AIR RAIDS

AND

CIVIL DEFENCE

By

L. M. CHITALE, F.R.I.B.A., A.M.T.P.I.,
Chartered Architect and Town Planning Consultant;
Chairman, Board of Studies in Drawing and Architecture,
Madras University

SECOND EDITION

1942

SECOND EDITION 1942

L. M. CHITALE, F.R.I.B.A., A.M.T.P.I.
AUTHOR & PUBLISHER
ORIENTAL BUILDINGS, G. T., MADRAS

PRINTED AT
THE MADRAS PUBLISHING HOUSE, MOUNT ROAD, MADRAS

PREFACE TO THE SECOND EDITION.

The favourable reception which the first edition had at the hands of the Authorities and the Public in India, Burma, Ceylon, etc. and the growing appreciation of the value of Civil Defence measures for protecting the civilian population and their property from destruction by modern methods of warfare compelled me to issue a revised and enlarged second edition, at this juncture.

The creation of a separate portfolio for Civil Defence and the increasing activities of Government in the vulnerable areas of India prove the need for concerting effective A.R.P. Measures immediately to face the danger which threatens to overwhelm the country, from the East and the West.

Fortunately India has been spared the horrors of air attack and is in a position to profit by the experiences of many unfortunate nations. The consequences of air raid though disastrous have shown themselves to be not uncontrollable if appropriate steps are taken in advance. Bombers have got through, as Baldwin predicted, but not without great difficulty. High explosive bombs have not proved impossible of resistance and gas, contrary to expectation, has not been resorted to by aggressors. Incendiaries have done greater damage than we once supposed and the need for helping those who escape unhurt but who lost their homes have now been shown to be as important as the precautions required for the injured and the maimed.

The book has been considerably enlarged and rewritten in many parts. Events, however, have supported the main hypothesis enunciated by the author in the First Edition. All available information and data have been examined and incorporated to suit Indian conditions. A new chapter on Camouflage has been added; while the chapter on A.R.P. organisation has been considerably enlarged.

The author is indebted to the numerous Government Departments and Public Institutions for their encouragement offered to this pioneer effort. His sincere thanks are due to his office staff for assistance in compiling this publication. He is also deeply indebted to the numerous Books, Reports, Journals, Periodicals and Illustrations referred to.

MADRAS, 15-4-1942 — L. M. CHITALE

CONTENTS

ABBREVIATIONS USED

A.R.P.H.	Home Office A.R.P. Handbook.
A.R.P.M.	Home Office A.R.P. Memoranda.
J.A.R.P.I.	Journal of the Air Raid Protection Institute.
J.I.C.E.	Journal of the Institute of Civil Engineers.
J.I.M.Cy.E.	Journal of the Institution of Municipal and County Engineers.
J.R.I.B.A.	Journal of the Royal Institute of British Architects.
J.T.P.I.	Journal of the Town Planning Institute.
I.C.J.	The Indian Concrete Journal.

LIST OF PLATES

LIST OF ILLUSTRATIONS

INTRODUCTION.

The darkening European horizon has given a new significance to the arguments advanced on social and æsthetic grounds against the uncontrolled expansion of cities.[1] Overcrowding and congestion of people and buildings, thoughtless association of different kinds of activities, inadequacy of water, air and ventilation and scope for movement, the dominant features of modern urban communities have made cities, danger spots of national security. This is the lesson which recent events in Western Europe teach. Men and women are fleeing from the great city in search of safety to country villages. It is now evident that the normal pattern of our existence in peace time is such that it is not merely useless in time of war, but a positive menace to life and limb. Urban surveys and statistics have demonstrated their unfitness even in times of peace. " Never go to cities " said the Upanishads, although with a different object. In the huge agglomerations of men and buildings breed the danger " beating down the will to live " and intelligent citizens are already leaving the hearts of cities to their outskirts, as the American movement of depopulation and blighted areas show.

Are great cities a menace? The weapons of air attack leave no room for doubt. It needs £360,000 a day for A.R.P. and evacuation alone for a tiny country like England just to reduce the quantity of destruction. As long as the threat of war remains so long will the Exchequer be drained. In addition there is the expenditure on coastal patrol and other services organised to deal with the risk. Inconvenience to the people and the strain upon the nerves of citizens should also be added.

The price we pay for city life in times of peace is serious if not spectacular. The loss of efficiency, the harm to health, the waste of resources and energy are hard to evaluate. Careful investigation alone will open our eyes to this appalling waste in our civic organism. If municipal finance spent upon ameliorative measures, urban sanitation and the like are an index to the inadequacy of our civic

[1] **W. A. Robson, " Evacuation, Town Planning and the War." The Political Quarterly—Volume XI, No. I, Jan.-March, 1940, pp. 45-58.**

organism to meet the needs of peace, expenditure upon A.R.P. might be taken as the index to the unsuitability of cities in times of war.

In spite of immense sacrifices and expense the feeling is prevalent that the risk cannot be avoided. France where the need for A.R.P. was visualised ten years ago—in fact a scheme for evacuation was prepared in 1930—paid heavily for the first mass air attack of the Nazis. Two hundred and fifty people lost their lives and 650 were injured in the heart of Paris claimed to have been equipped with all the anti-aircraft devices.

This is because the root of the problem remains unaffected. " Hitlerism will never be defeated by counter-Hitlerism. It can only breed superior Hitlerism raised to the Nth degree."[1] " Every new weapon of war inevitably results in a counter-weapon on the part of the adversary of even greater effectiveness."[2] Air attacks carefully planned to destroy cities as they are, can be successfully counteracted only by measures which change their form, their plan and pattern. The logic of this argument will become apparent when we study carefully the kinds and capacity of the weapons used in air attacks.

Defence is no longer the repelling of invasion but the protection of the home and the soil.[3] Even in the West it is recognised " that the troubles to-day cannot be cured by arms and armaments. We have to go further and deeper."[4] And considered opinion is therefore gathering round the view that proper planning of civic communities, careful selection of centres of population and industry and thoughtful balance between the built-up and open areas are necessary to meet the air menace.

This danger is three dimensional and hence the need. What a shield could do when blows and arrows were weapons of the war ; the fortress, the rampart and the moat had to do, when infantry and cavalry marched against the enemy. Against aerial bombs they offer no safeguard ; in planning alone lies chances of survival.

[1] Mahatma Gandhi : The " Harijan ", 22nd June, 1940.

[2] The Pope's Easter Broadcast, London, April 13, 1941.

[3] Robson.

[4] Chamberlain : Address to the General Assembly of the Church of Scotland at Edinburgh during May 1939.

Planning is a necessity to readjust our urban communities and to provide us towns fit to live in, and cities to be proud of, where our people can dwell in comparative security. How will these prevent air raids? As Chapter VI would show properly planned cities and towns would render air raids uneconomic and not worthwhile. Herein lies the safety for cities and civilization without the aid of Le Corbusier and his deep underground cities or Commodore Charlton and his human hives overground. This ideal towards the very best, will give us the correct basis of development. Even if the weapons are made more powerful such a plan would render possible protective measures.

Absolute security is possible only if the world forgets the aeroplane or submits to the Gandhian ideal of non-violence in matters international or internal. Mere conventions and agreements or Leagues and Covenants do not help. The Geneva Gas Protocol of 1925 prohibited the use of poison gas in war but in Abyssinia barrels of liquid mustard gas were used.[1] And it is only in the name of 'civilization' that women and children are machine-gunned and killed by champions of 'civilization' in Europe. In a world with such leaders, limiting wars to warfields is unworkable. When women and children and non-combatants form the targets of attack by bombs and blockades what can the Kshatria ideal of zoning warfields do?

Until human nature improves and man gets humanised there is little hope, as Sir Clement Hindley points out, of obtaining peace for mankind from the threat of air raids.[2] When will it change? Centuries of 'progress' has left man where he was in the days of Cain. If it is idle to hope for improvement there is no alternative but to plan and plant the communities in such a way as to infuse strength into them to resist and recover from air attacks.

Will readjustment of our cities, towns and villages to meet the needs of war injure the needs of peace, the requirements for health and comfort of those who should dwell in them? Fortunately the measures necessary for air resistance are eminently helpful to enhance civic comfort. This is a silver lining to the threat of air attack gathering in the sky and screening the dawn of hope

[1] A. A. Spaight: Air power in the next war.

[2] Presidential address. Institution of Civil Engineers. J.I.C.E., Nov. 1939, p. 4.

and survival. Town planners therefore view this new threat as a blessing in disguise. For the reforms which eminent authorities in public health, sociology, civic economy, dietetics, traffic control, etc., have been recommending these many years are essential since they are eminently helpful to face the high explosive, the incendiary bomb and liquid poison gas. The open pattern required for safety is ideal for efficiency.

Details of researches in sciences directly affecting human welfare that call for change in our mode of life are discussed in their relevant places. Emphasis should, however, be laid upon the most vital factor in human welfare, namely the maintenance of the proper balance between organism, function and environment (men, occupation and land) on which alone a stable civilisation could be built. The lessons which human ecology has to teach us, has immense bearing upon the problem of safety. The Royal Commission on the Geographical Distribution of the Industrial Population and the recent cry of 'grow your own food' in Great Britain, the back-to-village movement in other countries are but feeble manifestations of the unconscious recognition of the vital need to restore the lost balance between these fundamental constituents of society. And this can be solved as sociologists have pointed out only by a correct proportion between agriculture and industry, land and labour, cities and towns, work and wealth. If air raids compel us to realise and adopt this as our goal, they would not have been in vain.

To this lack of balance and proper spacial distribution of population and industry is due the difficulty of securing safety for the citizens and civilisation in Europe, in spite of the enormous expense and discomfort. In the words of Mahatma Gandhi "it is not unreasonable to presume from the state of Europe that its cities, its monster factories and huge armaments are so intimately interrelated that one cannot exist without the other." For "a society which anticipates and provides for meeting violence with violence will either lead a precarious life or create big cities and magazines for defence purposes."[1] The legacy of the industrial revolution was one-sided, and the consequences we are witnessing to-day ; bread without butter and diet without nutriments ; homes without housewives, schools without children, children without schools, lamps without light and strain without war !

[1] The "Harijan", Jan. 13, 1940.

If India neglects these valuable lessons the same difficulties are bound to be in store for her. The situation is not beyond reform if attempted at present. We are yet to discover the optimum spacia distribution of population and sooner an effort is made the better Industrialisation awaits India and its evil consequences can be avoided only by careful planning in advance.

A.R.P. in India is rapidly gathering momentum. Long before the declaration of hostilities in Europe steps were taken to prepare schemes for India, although the September crisis gave a fillip to A.R.P. activities and to public interest in the matter. Information available indicates that A.R.P. in our country covers such items as black-out, wardens, sandbagging, sirens, first-aid parties, etc. Attempts at air raid shelters have also been made; and A.R.P. organisations are being built up in important cities. Medical aspect of A.R.P. has drawn wide attention.

However necessary these may be, events in Europe indicate that they cannot assure protection, even if our finances permitted their adoption on the British scale, to 30 million people inhabiting more than 1,000 centres.

If we should succeed in obtaining air security for our country every effort must be made to discover and apply measures that would be both economical and efficient. Is this possible when the threat of attack is at our doors? " So long as the possibility of attack exists, it is necessary to create organisations to minimise the consequences of attack and as it would not be possible to improvise effective measures on the spur of the moment in time of emergency, preparation must be made in time of peace.

" It is of essence of any such preparation that the civil population should be informed of the present and future possibilities of air attack and instructed in the precautions designed to meet it." [1] This warning of the Home Office of Great Britain has special significance to India. A correct perspective is essential to make our plans efficient. Effective public opinion is needed to launch comprehensive schemes.

[1] **Home Office A. R. P. Circular dated 9th July 1935, p. 2.**

In the following pages an attempt has been made to deal with the problem of air raids and how best we could face this danger. The weapons used in air raids, their terrible potentialities and the destruction caused by them are first dealt with since a correct appreciation of the position is essential for formulating measures to combat them. Prevention is the most desirable solution, and the measures generally adopted, is described next. Since total prevention is impracticable the following three Chapters deal with the question how best the people could be protected, city structures could be made resistant to air raids and the supply of essential services immunised from the risks of dislocation and destruction. The plan and pattern of urban communities that would resist and recover from air raids are described next. In the four chapters that follow are indicated emergency measures and precautions for immediate adoption; evacuation and dispersal; air raid shelters; precautions to structures and services; camouflage and light obstruction. A.R.P. organisations and education to render these reforms possible and effective are outlined in the concluding chapter.

The literature on A.R.P. is rapidly growing. Government departments, expert bodies and manufacturers have published valuable books and pamphlets. Research work is being carried on under their auspices. The experiments of the Home Office of Great Britain and their A.R.P. Handbooks and Memoranda constitute a mine of valuable information to which the reader must turn for further details. The aim of the author, however, has been to present the different aspects of the problem in their true perspective, concisely over a comprehensive canvas without which the approach to the remedy is impossible. He would consider his labours amply rewarded if the following pages succeed in stimulating a healthy public interest on this vital question before the peril overwhelms the country.

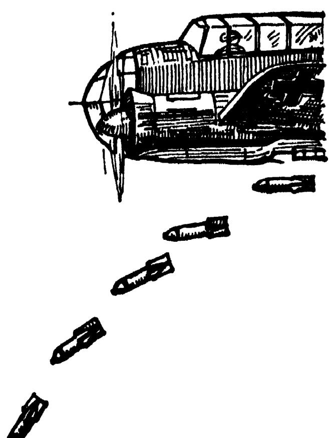
CHAPTER I

AIR ATTACK: MEANS AND METHODS

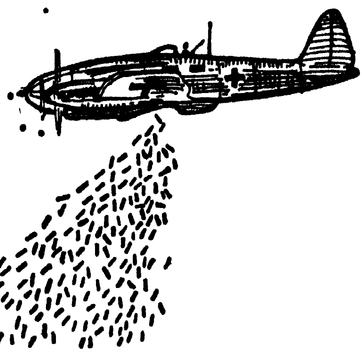
CHAPTER I

AIR ATTACK: MEANS AND METHODS

Air attacks are intended to destroy the morale, property and lives of the inhabitants of the enemy country in the shortest possible time. The means and methods of achieving this are, therefore, carefully planned. Thickly peopled zones, and closely built-up areas and strategic centres are selected. Squads of bombers drop different kinds of bombs in quick succession. Their aims are accomplished by demolishing railway stations, harbours, power-houses, telephone exchanges, bridges, and other key positions; by destroying factories, industries, godowns and warehouses; by spreading fire; by harassing people by machine-gunning; by poisoning men, their food, clothes, roads and buildings.

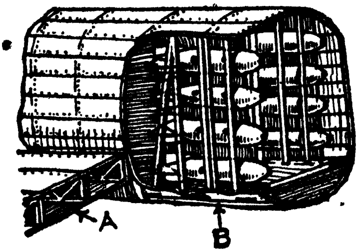


High explosive bombs released from a bomber



Incendiary bombs released from a bomber

The weapons designed for this purpose are: the high explosive bomb, the incendiary bomb, machine-gun, and liquid poison gas. Bombs are released from air-craft and liquid gas is also directly sprayed from the plane. An air-craft bomb is a container holding high explosive, or incendiary mixture or gas,



High explosive bombs kept in position in the fuselage of a bomber

with means of detonating, burning, or discharging the filling. A bomb is simply released from an air-craft and is shaped to minimise the resistance offered by the air. Bombs are cylindrical or streamlined, the length of the body being about 4 to 6 times that of the diameter.

The High Explosive Bomb[1]

There are several kinds of high explosive bombs. One variety, called armour-piercing, is designed for deep penetration and is used for demolishing factories and other protected centres. Another variety known as the general purpose bomb is designed for maximum destruction in built-up areas by blast and splinters.

High explosive bomb used in Spanish raids

High explosive bombs are classified according to the weight of their case or containers into heavy, medium and light case. Heavy case bombs are also classified as armour-piercing and semi-armour-piercing; medium case; as general purpose, and small bombs as fragmentation or anti-personnel. A special class of light case bomb is classified as anti-submarine.

High explosive bomb used by the R.A.F.

[1] This section is largely based on the Home Office A.R.P.II.5 "Structural Defence", and reports of recent raids.

The weight range of H. E. Bombs is given below.:—

Type of bomb	Charge/weight Percentage	Gross weight lb.
Anti-personnel	15 to 20	20
Light case	50 to 60	50 to 4,000
Heavy case	25 to 40	
Medium case	Small	

In the following table are given typical dimensions for a few bombs. In practice they vary considerably. The figures in brackets in the second column give the length of bomb carcass, that is, the part enclosing the charge.

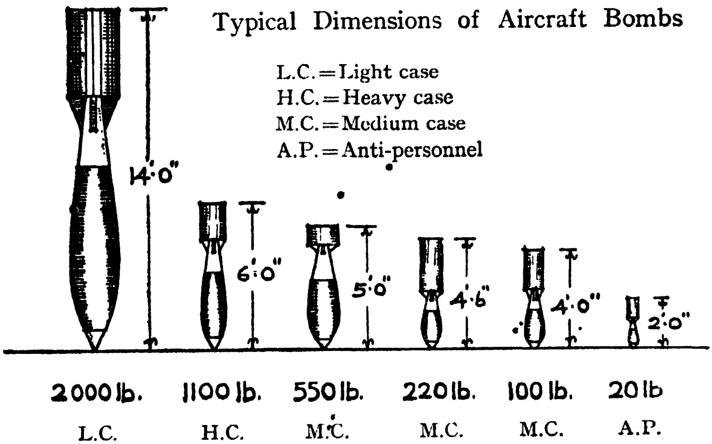
Bombs	Length Ft.	Diameter Ins.	Sectional Density* Lb. sq. in.
2,000 lb. light case	14 (9)	24	4·4
1,100 lb. heavy case	6 (4)	12	9·7
550 lb. medium case	5 (4)	15	3·1
200 lb. medium case	4½ (2)	10	2·8
100 lb. ,, ...	4 (2)	9	1·6
20 lb. anti-personnel ..	2 (1)	5	1·0

*Mass/Maximum Cross-sectional area

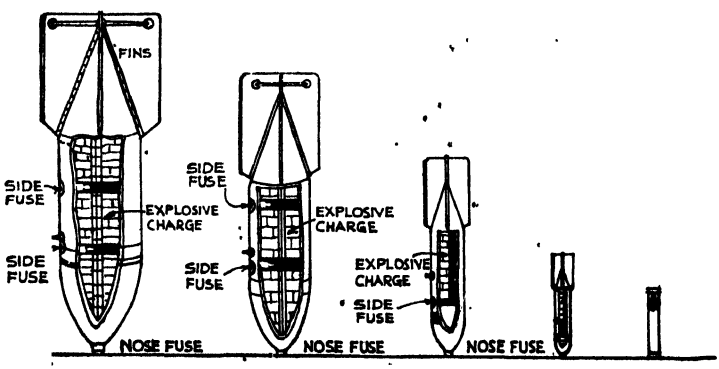
In the next page are shown various types of bombs in use at the present time, including the Incendiary, the High Explosive, the Armour-piercing, the Delayed action and the Oil bomb.

Though various standard type bombs are given as used by the *Luftwaffe*, bombs similar in size, though differing in shape, and generally aerodynamically superior to the German, are being used by the British bombers upon legitimate targets in Europe and Africa. The bomb most generally in use to-day is the high explosive type with contact fuses. These fuses are two in number in the larger types and one in the smaller bombs, placed on the side of the case to facilitate manipulation. The case is of steel and kept thin so that there is a very large bursting content. The armour-piercing types are, of course, largely used against warships and forts and the whole case is very much thicker than the high explosive general purpose type. The time gear of a delayed action bomb, in the

majority of cases, is clockwork, but in some cases an acid is used which cuts through a soft metal plate and causes explosion. The oil bomb, which may be of various sizes, is filled in some cases with petrol, thus becoming tremendously powerful incendiary bomb.



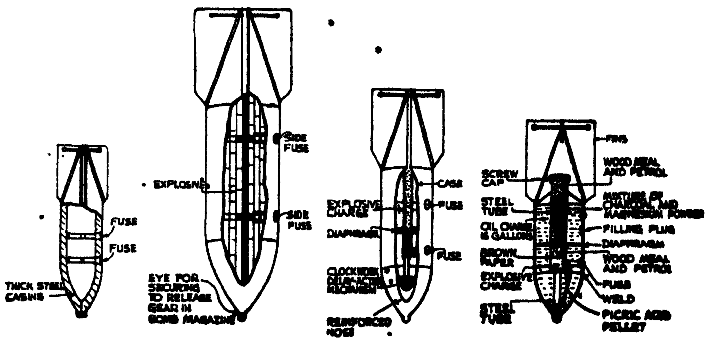
In other cases it is filled with crude oil, which is ignited by a small petrol charge, as shown. The destructive force of high explosive bombs is due to the various effects of explosion and fragmentation, of expansion, and of suction immediately following, whereby the pocket of rarefied air produced is filled by the pressure of the surrounding atmosphere.[1]



German bombs released over Great Britain

[1] "Illustrated London News", Oct. 5, 1940, p. 435.

A heavy case bomb is designed to withstand the shock of impact and to penetrate into or through the object struck, before detonation, and a delayed fuse is inserted.[1] Its potentiality will be developed only when it hits specially protected targets and it is hoped that the armour-piercing bomb is likely to be restricted only to that purpose. Heavy case bombs vary from 250 to 2,000 lbs. in weight and their frequent use is unlikely as heavier bombs alone are effective and fewer only can be carried.



Typical British bombs

In the medium case bomb, the explosive content ranges from 25 to 40 per cent. of the weight ; and it is less strong to withstand the shock of impact. Still with a delay fuse it can penetrate some distance and would ordinarily be strong enough to perforate several concrete floors of the thickness usual in multi-storeyed buildings. Medium case bombs range from 50 to 1,000 lbs. and they may be designed to produce intense blast as well as fragmentation. Heavier ones are possible, but tactical considerations would make them vary between 110 to 660 lbs. as the most practical against civil buildings.

Light case bombs contain 50 to 60 per cent. or more of explosives and are used for maximum blast effect and will be used where blast is the decisive factor. If used for underwater attack for docks,

[1] Time-bombs seriously affect traffic and A. R. P. services. They have been used by the Nazis over London. A time-bomb weighing nearly a ton fell near St. Paul's and the Cathedral was saved by the heroism of a bomb disposal squad which dug it out of a depth of 27 feet. It was a delayed action bomb which exploded inside the debating chamber of the House of Commons that destroyed walls although fire helped to burn it down.

In a Midland town a delayed action bomb necessitated the evacuation of a number of families.

reservoirs, etc., they would be fused for delay. Such bombs may be of any size.

The fragmentation or anti-personnel bomb usually weighs about 20 lbs. and is designed for use in large quantities to cause fragmentation, to cause injury to persons in the open and is fused to fire on impact.

The Japanese used this with deadly effect over the civilians of Rangoon on Dec. 23, 1941. In a single raid over 1,000 people were killed and larger number injured. Rangoon experience shows that A.-P. bombs do not penetrate very deeply before exploding. They burst on impact, and Japanese raids on Rangoon have shown that the fragments are scattered all round keeping very low and close to the ground. How low the fragments travel will become clear when we realise that in several places where the bombs exploded, the road was scarred on the surface for some considerable distance from the actual crater by low-flying fragments. The kerb stones of the pavements were smashed to pieces. The ground floors of shops and houses were heavily scarred and chipped. All glass for hundreds of feet around had been smashed.

Even those who lay flat on the ground when they heard the bombs coming, were killed or wounded. The destruction and slaughter were simply frightful. Mangled corpses, arms, legs, pieces of flesh and blood lay scattered all over the road pavements and walls of buildings.

It is evident from Rangoon experience that fragments attacking brick walls do not penetrate more than four or five inches into the brick ; they cause a good deal of ploughing up of the brick. Even a nearby explosion cannot damage a brick shelter. In no case, they penetrated right through the brickwork.

A direct hit is, however, disastrous to normal buildings. One A.-P. bomb burst in a wooden bungalow, completely demolished half the structure and created a crater 25 feet in diameter.

Explosives used as fillings for bombs are, Gun-cotton (dry), Tri-nitro-toluene (T.N.T.), Dynamite No. 1, Amatol 80/20. A high explosive bomb has a filling of high explosives with devices for detonating the filling. The impact causes a needle to fire a cartridge

cap contained in the head of a detonator, which in turn detonates another intermediary filling which initiates the detonation of the main filling.

The means of detonating the filling, or fuse may be (1) instantaneous, causing the bomb to burst on impact with the target or (2) delay, introducing a time interval between impact (which starts the fuse mechanism working) and the detonation of the bomb. This gives the bomb time to penetrate the target before bursting. The former is usually fitted to the nose of the bomb while the latter is attached to the tail. Some bombs carry both types.

The high pressure generated by the conversion of the solid explosive into gas, causes the metal case to swell until it reaches about 1½ times its original diameter, when it bursts into fragments or splinters. The time taken for the detonation of the main filling of a typical 500 lb. bomb may be assumed to be of the order of one ten-thousandth of a second.

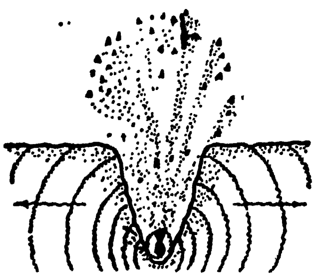
On explosion, the explosive inside is suddenly converted into gas at a very high temperature and pressure. The effect is that of a sudden blow on immediate surroundings, the violence of which depends on the velocity of detonation and the pressure produced. When the bomb bursts on a flat surface the gas expands to a radius of 20 to 25 feet.

In the air which surrounds the explosion itself, is created the blast pressure. This air-borne shock wave is analogous to an ordinary sound wave except that its amplitude and velocity are higher. It is propagated by wave motion through the air without bodily movement of the air and persists for considerable distances.[1]

Apart from the shock wave, generated in the air, analogous waves are also generated in the earth or other target in or on which the bomb explodes. If the bomb penetrates to a sufficient depth in the earth the earth waves are created which may prove very dangerous at close distances.

[1] A large proportion of Britain's air raid casualties have been victims of shock. Many have been hurt by splinters or falling masonry. To absorb shock and resist splinters, American medical authorities are devising a bomb-blast jacket of sponge rubber reinforced by thin plates of plastic material.

A well-known British Surgeon, who was in the Royal Medical Corps in the last War, has pointed out that the shell shock which soldiers experienced in the last world war " were not nearly as bad as the spasmodic bombings that occur in this war."



The effect of a high explosive bomb bursting in the ground

Detonation is followed by the effects of blast, earth movement and earth waves, fragmentation, disruption and cratering. In sequence the effects of a bomb are, penetration, impact, fragmentation, rupture and cratering. Home Office authorities recognize the difficulty of accurately stating the effects of these, produced by a bomb. Artificial experiments, they rightly feel, cannot give correct results but a fair degree of reliance could be placed on proper calculation.

When a bomb bursts the hot compressed gases escape and deliver an instantaneous but localised blow on the surrounding air, and their pressure on detonation has been variously estimated at between 100 and 650 tons per square inch. The maximum distance of the outward movement is stated to be of the order of 25 feet when the bomb bursts on a flat surface in the open air. Experiments indicate that blast from such an explosion sends a shock wave of an initial positive pressure phase followed by a negative (suction) phase which is probably followed by a small decaying oscillation. At 50 feet from a 500 lb. bomb the maximum pressure in the wave is of the order of 6 lb./sq. inch and that the durations of the positive and negative phases are respectively, 5 milli-seconds and 25 milli-seconds.[1]

[1] When a German Heinkel Mine-laying Air-craft crashed in a garden it burst into flames and exploded. A complete row of houses was demolished at Clacton-on-Sea, Essex, when this happened on the night of 30-4-40. Two civilians were killed and some 160 people injured. This severe damage was caused by the explosion of a mine carried in the air-craft.

A raider crashed with a full load of bombs in South-east London. Several buildings were demolished.

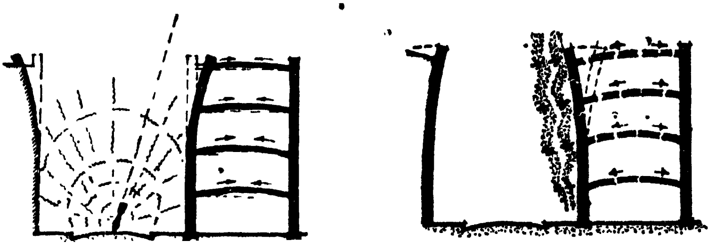
When a German plane crashed on houses on the fringe of an Essex coast town, an explosion occurred, and several houses were wrecked. Serious damage was caused to a greater part of two streets of houses and a large new block of flats was badly damaged. The whole back of one pair of houses was torn off. A house front was blown away.

On 15-3-40, one high explosive bomb hit a dance hall in London, wrecked it, and its blast overturned a crowded bus outside, which caught fire. Several passengers were killed.

When a bomb fell in a London street, the blast blew a car into the air, over the tree-tops and through the roof of a house, where it finally came to rest on a table in a back room forty-four yards away from its original position.

The total duration of the combined positive and negative phases is about 1/30 of a second whether the distance is 50 to 200 feet from the bomb, but the duration of the negative phase varies from three to six times that of the positive phase. The wavelength of the initial phases is about 30 feet.

The pressures in the subsequent decaying oscillation are much less than those in the initial phases, and it appears that any structural damage occasioned by the blast will be due to the initial phases.



Effects of the positive and negative phases of blast upon the walls of a building

Much has been written about the suction effect produced by detonating bombs for they are contrary to anticipation, since debris etc., are thrown towards the bomb site. This is due to the true

One bomb demolished a row of houses in London in March 1941.

A time-bomb exploded in Regent Street during September 1940. The windows on both sides of the street were blown out.

An unidentified plane in January 1941 dropped one bomb in Donmore Avenue, South Circular Road, Dublin and destroyed two houses, seriously damaged a third and did slighter damage to other houses in the area. An official announcement stated that some 20 people were injured, but none seriously. The explosion shook a big area of the city and caused widespread alarm. The bomb blew off roofs, windows and walls and smashed panes of glass within a radius of half a mile.

A solitary plane dropped two bombs in a field near a residential quarter of a south-west England town. Several houses were damaged and there were some casualties, including a man in the field, who was killed instantly and a few people were seriously injured. A number of cattle were also killed.

People killed by blast have shown no external signs of injury ; the main effects have been on the lungs, the delicate tissues of which have been shattered by the terrific impact.

Thin people appear to be more likely to suffer from bomb blast than the fat. It would seem that their extra flesh offers some protection, yet according to the experts who have studied the subject in this war, thickly-clothed persons are more liable to receive injury than the thinly-clothed. Older folk suffer less than the younger.

suction effect of the negative component of the shock wave, that is to the wave of rarefaction following immediately on the wave of compression.

A bomb explosion particularly in a confined space such as a street or building, will always tend to give chaotic and apparently freakish effects, which are probably attributable to reflections of the pressure from a multitude of surfaces.[1]

In the case of bombs, penetration is not an end in itself but is primarily a means to an end, which may be destruction by explosion, or fire or the distribution of war-gas. Various formulae are met with in literature and are assembled together and the adjoining table gives the penetration into various media, based on published results, for a 500 lb. bomb of the assumed sectional density M/A = 5 lb. sq. inch. Depths are given in feet, and the striking velocity is assumed to be 820 f.s.

[1]The phenomena of explosions is remarkable, and in fact in many cases almost unexplicable. Thus there have been cases in London of bombs falling near houses in which all the glass windows remained intact whilst the whole of the crockery, inside the house has been shattered. There were also many cases of individual houses completely blown to pieces with large bombs whilst the windows of neighbouring houses were untouched, although in many cases windows were shattered half a mile away from the explosion. It is pointed out in the Air Raid Precautions Memorandum No. 16 that there have been cases where a bomb of 100 lbs. has detonated on the corrugated iron roof of a single storey factory without causing very much damage, whilst there are other bombs which have fallen clean through the roof on to the floor of buildings and done little damage to surrounding machine tools. There are cases of heavy bombs, up to half a ton in weight, that have fallen within 30–40 feet of a workshop and done no damage except stripping off the roof. As against this, however, the extent of the damage caused is often out of all proportion to what might have been expected.

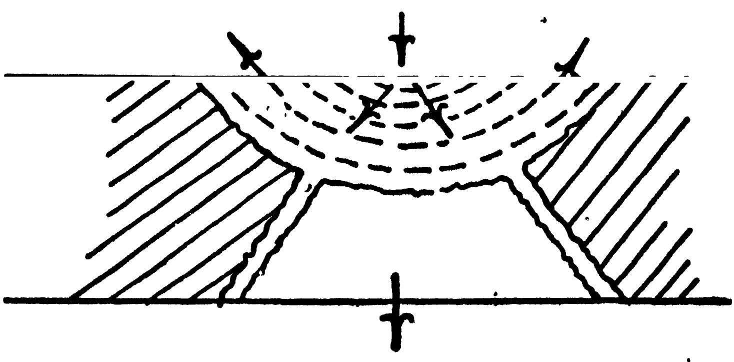
Some of the recent R.A.F. bombs possess terrible exploding capacity. " Five times the blasting effect of any bomb previously dropped by the British Air Force", is how the new type of bomb used in the British raid on Emden, the German naval base, during April, 1941. The new bomb is filled with an extremely effective explosive, capable of destroying buildings over a wide area. The concussion would be felt many miles away. In view of the devastating nature of these bombs, which are of very large size, it was difficult to find a sufficiently large uninhabited area in England for testing their blasting powers.

The terrific devastation these bombs can cause may be gathered from the report of the Air Ministry News Service. A huge bomb fell ; there was a colossal flash and the crew of the machine saw great masses of debris flung high into the air. These were no ordinary fragments, proving that enormous destruction had been done. Moreover the debris must have been thrown to a great height as there was a distinct interval before it settled down again. It seemed as if a whole building had been thrown into the air. One pilot saw " houses take to the air ".

Penetrations (in ft.) for 500 lb. bomb; M/A = 5 lb. sq. in.: S. V. = 820 f.s. Normal incidence.

Material as described by the authors	Metz Committee (Poncelet)	Petry	Vieser	Peres
Limestone	3.0	2.5	—	—
Ferro-concrete	..	2.1	1.5	1.7
Ordinary concrete	—	—	2.1	3.2
Stone masonry	—	5.4	—	—
Brick masonry	10	9.3	4.3	—
Sandy soil	20	17	10	—
Soil with vegetation	—	22	12	—
Ground of average firmness	—	—	—	17
Soft soil	—	34	19.5	—
Loose earth	25	—	—	26

Penetration depth will decrease if departure from normal incidence occurs and as the angle of impact measured from the normal to the target, increases, until at a certain angle of impact the bomb will merely ricochet without penetrating appreciably. Moreover, for angles between zero degree to the normal and the angle of ricochet, that is, for all practical impact conditions the bomb, after penetrating a certain distance into the ground, usually deviates from its course, generally in an upward direction.



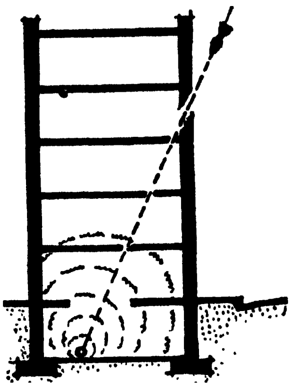
DIAGRAMMATIC REPRESENTATION OF SCABBING

The effect on the target varies considerably with its physical properties. The path followed by a bomb when penetrating natural rock or soil is rarely a straight line from point of entry to its final position; variation in the resistance of the soil is liable to cause the

bomb..to deviate considerably from its original direction. The longer the path the greater is the tendency to deviate.

A direct hit causes scabbing. Scabbing consists in flinging off from the rear of the target, of a piece of the target opposite the part struck, and may occur whether the target is perforated or not. The scab or plug is usually of the shape shown in the above diagram.

When a typical 500 lb. medium case bomb with a delay fuse falls, at a steep angle, on a multi-storeyed building having a roof and floors of reinforced concrete each six inches thick, it can perforate the roof and five floors before exploding, provided it does not break up and is not deflected from its path by obstructions such as steel girders. The total thickness penetrated by the bomb is thus about 36 inches. But the corresponding depth of penetration into a single thick, reinforced concrete block would be less, other things being equal, because the penetration is not helped by the scabbing.



Delayed action high explosive bomb penetrating a multi-storeyed building

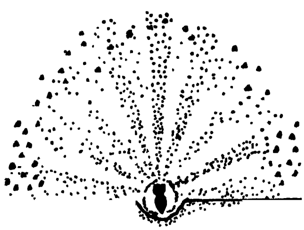
A heavy case bomb being designed for penetration prior to explosion, its capacity for penetration is comparatively definite; but the penetration of delayed action medium case bomb into resistant material, such as concrete, or even into semi-resistant rock such as chalk, is doubtful. Not being designed specifically for penetration the case is liable to deformation on impact with resistant material to an extent which is scarcely predictable.

When heavy case bombs fall on soil, gravel, shingle, and chalk, they tend to diverge from their original direction after penetrating some distance, and to follow an erratic path influenced by local obstruction. Sometimes the path is a fairly uniform curve, often concave to the ground surface and turning upwards towards the last stage. If a bomb meets clay at an early stage the total penetration is increased.

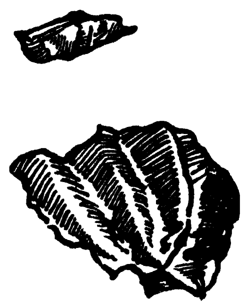
A typical heavy case 500 lb. bomb falling from a considerable height could penetrate to a vertical depth of 25 feet of chalk or dry sand. 1⅜ times in loam, ordinary soil; 2⅜ times in clay;

3/5 times in gravel. Hence the maximum vertical penetration of a typical 500 lb. heavy case bomb in ordinary soil would be 42 feet.

Fragmentation is equally dangerous and difficult to judge. It is not easy to discover the direction, number, shape, weight and velocity of all the fragments which are shot out when the casing of the bomb bursts. The total number of fragments from any ordinary bomb runs to thousands, and although by far the greater percentage may weigh less than an ounce, they may nevertheless be lethal to human beings and animals. The number of fragments range between 2,000 and 6,000 for all sizes of bombs from 25 lb. and the average size of the fragments tends to increase with the size of the bomb.



Fragments of a bomb exploding on impact



Bomb fragments taken out from an injured person in Spain ; actual size

The maximum velocities attained by fragments probably lie within the limits of 4,000 to 7,000 ft. per second for most bombs and are reached within less than 10 ft. from the bomb. Thereafter the fragment velocity drops owing to air resistance. At about 50 ft. from the bomb the velocities probably lie between 2,500 and 5,000 ft. per second, the higher velocities being associated with the larger bombs.

The effective range of fragments is about 500 ft. but the gross range, if the bomb is fired above ground in the open, is from 300 to 1,200 yds. depending on the kind and size of bomb, and its charge-weight percentage. If the bomb bursts below ground the gross range might be halved.[1]

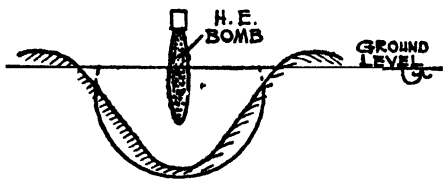
[1] The head of the German A.R.P. Department in the course of a two-column press statement admitting the destructive power of British bombs said that he had seen one splinter going clean through heavy doors and two thick walls.

In a given bomb the fragment velocity depends on the explosive used. But the depth to which a bomb fragment can penetrate structural materials depends on the weight, size and shape of the fragment, its velocity, the angle of strike and the material attacked.

An idea of the penetrating power of fragments could be had from the following table giving the thickness of various materials, recommended for protection by the Home Office of Great Britain.

Material	Thickness
	Inches
Mild steel plate or plates of an aggregate thickness, not less than	1½
Solid brickwork or masonry, not less than	13½*
Reinforced concrete, not less than	12†
Ordinary concrete, not less than	15‡
Earth or sand, not less than	30
Ballast, or broken stone, not less than	24

Cratering is another destructive consequence when the H.E. bomb bursts in the ground. The material is broken up and forms a



Formation of crater

cone-shaped pit called a crater. The size of the crater formed will depend on the kind of earth, the depth to which the bomb penetrates

* This thickness is suitable for sound brickwork in cement mortar, hydraulic lime mortar, or cement-lime mortar, or for coursed masonry in sound condition. For old brickwork, where the mortar is found on inspection to be weak and friable and for rubble masonry, the thickness should be increased upto double that given in the table, according to condition.

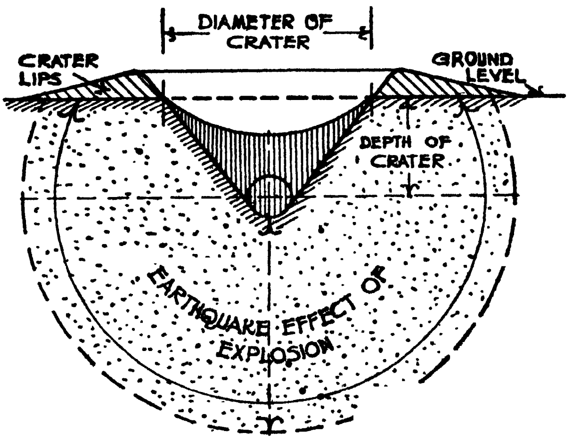
A cavity wall of brickwork with outer leaf 4½ ins., cavity 2 ins., and inner leaf 9 ins. thick offers resistance similar to that of a solid wall 13½ ins. thick.

† This thickness is suitable for concrete containing not less than 112 lb. of cement to 2½ cub. ft. of fine aggregate and 5 cub. ft. of coarse aggregate, with not less than 0.2 per cent. of reinforcement in each direction (total 0.4 per cent.) properly distributed.

‡ Ordinary concrete should contain not less than 112 lb. of cement to 12 cub. ft. of fine and coarse aggregate in combination.

before bursting, the weight and characteristics of the high explosive filling, and the amount of energy taken up in the bursting of the case of the bomb.[1]

Immediately outside the circumference of the crater are formed the crater lips and in addition, the ground near the crater will be cracked and shaken. The zone in which this happens will be bounded by a circle concentric with the crater but of larger diameter.



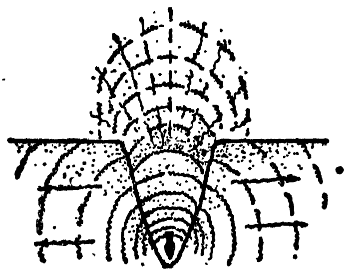
SHAPE OF A TYPICAL CRATER

The volume of material thrown out by the explosion will approximate in shape to a blunt inverted cone with apex below the centre of the charge. The amount of earth displaced by a bomb may be considerable and American figures for 300 lb. bombs and 2,200 lb. bombs amount to 90 tons and 1,000 tons respectively, the bombs having about 50 per cent. charge/weight ratio.

[1] The crater created by a high explosive bomb in the street of London was so big that a bridge had to be erected to facilitate transport.

A one-ton high explosive bomb removed from St. Paul's Cathedral compound and made to detonate produced a crater 100 ft. wide.

Apart from the damage resulting from the crater formation, a bomb bursting within a solid target, transmits pressures through the target in the form of waves, with or without translational movement of the material of the target.[1] The physical movement of the earth and pressure waves may damage underground structures and services such as water and gas mains, sewers, electric power and telephone cables. Reports from war areas state that medium case bombs penetrate roadways to a depth of about 2 ft. and their effect on the road was greater than that of similar bombs bursting on contact.



Pressure waves created when the high explosive bomb explodes within the target

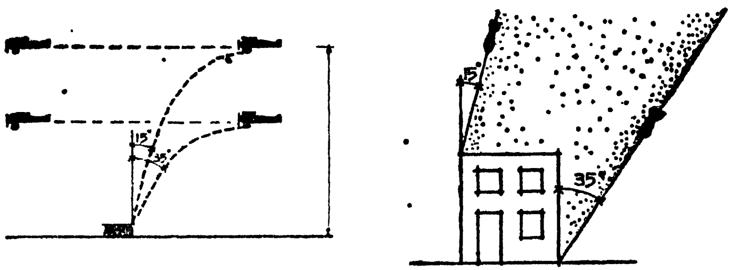
A trial experiment conducted by the Home Office showed the great potential danger to underground services by bombs ; water and gas mains, telephone cables, were severely damaged and shattered. A deep underground sewer escaped but with a heavier bomb it would have been destroyed. Another experiment made showed that when a heavy case bomb was detonated with the nose buried 2 ft. down in a slab of reinforced concrete 15 ft. by 20 ft. and 3 ft. thick, the concrete was completely disintegrated over a diameter of about 12 ft. and the slab was split open. Another trial showed that 15 ft. of first-class rock above an unlined underground chamber with a cross section of 4 ft. by 2 ft. 6 ins. would give full structural protection against a heavy case bomb weighing about 250 lb. while against a similar bomb of about 500 lb. about 20 ft. rock cover would be required.

In aerial bombing there is danger not merely to the roof but to walls and sides of buildings. For the angle of approach of the bomb when it hits the target is between 15 to 35 degrees from the vertical.

[1] The explosive force of air-craft bombs would become apparent when we realise that when the R.A.F. dropped the bombs on the target of French Coast during May towns on the English side of the Straits of Dover were rocked. Doors and windows of houses rattled and many a treasured family ornament was shaken from its shelf by the explosion of Britain's new and powerful bombs.

The approximate striking velocity and the angle of arrival for a bomb released from an aircraft flying horizontally at 200 miles an hour is given below.

Height of Release	Angle of Impact	Striking Velocity
Feet	Degrees	Feet per second
1,000	46	390
3,000	33	520
5,000	26	610
7,500	22	710
10,000	19	800
12,500	17·5	880
15,000	16	950



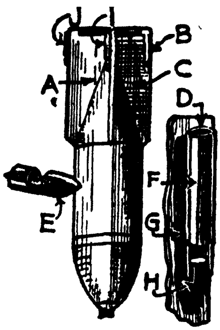
The angle of impact of high explosive bomb

Recent happenings have shown that these capacities attributed to the high explosive bomb are true. Contrary to expectations they have been showered over cities regardless of cost. The R.A.F. during one raid poured hundreds of tons over Kiel and the Nazis over two hundred tons over London during one raid.

British bombs " big, beautiful" according to Beaverbrook, have shown themselves to possess more terrific explosive power than those of the Germans. One-ton bombs and 2,000 pounds bombs have been used. Time-bombs have been utilised by the Nazis over London. The screaming device has been resorted to by Germans to terrorise the people.

The ear-drums of the public, which have had such a strain put upon them by the sound of bombs and guns, are to be protected by ear plugs like the following issued freely by the Government. Several million pairs were issued through local authorities.

One-ton bombs have penetrated over 20 ft. into earth and craters hundred feet wide have been created when such bombs were detonated artificially.



Screaming device attached to H. E. bombs

Ear plug used in Britain to protect the ear-drum from destruction by the noise of bomb explosion

The explosion of high explosive bombs have proved disastrous to objects closeby. Several houses in streets have been demolished by the explosion of a single bomb. The windows in rows of houses have been shattered by blast of a single explosion. The terrific effect of a nearby blast has been demonstrated in the streets of London where omnibuses and trams have been blown away several yards and some times over the roof of distant houses.

The earthquake effect or vibration created by the explosion of bombs which penetrate into the ground has also been demonstrated. The Southwark Cathedral was cracked by bomb explosion, underground.

During a raid a bomb buried itself in the ground just outside the Lady Chapel. This at first was believed to be a delayed action bomb; but it was found that it had burst underground. It was not till recently that cracks were noticed in the east wall of the cathedral, no doubt as a consequence of the underground explosion. This injury to the fabric, it is believed, might well prove to be more serious than that caused in later attacks. An idea of its terrific effect would become apparent when we learn that houses on the

Kent coast have been shaken by the heavy explosion caused when the R.A.F. delivered its big attacks on German invasion bases.

It has further been demonstrated that although very terrible in their effect, H.E. bombs are valuable complements to incendiary bombs, and are used in combination with them to destroy cities and built-up areas.

Incendiary Bomb[1]

To set fire to a city and destroy is easier and cheaper. Incendiary bombs are used for this purpose. They burn with intense heat and spread an effective fire and so many fires are started as to make the task of dealing with them by the fire brigades impracticable. A large bomber can carry between 1,000 to 2,000 small incendiary bombs which if scattered over built-up areas, and not dealt with within two or three minutes after falling, might start so many fires that no fire fighting organisation could be expected to deal with them all. The water-mains may be damaged or drained dry for fire fighting elsewhere, with the result that there might not be enough water nearby for a fire engine to use; or again, roads might be damaged by high explosive bombs and so prevent a fire engine from reaching the site of the fire. It should be remembered that sufficient appliances may not be available to deal with the fires caused by incendiary bombs; and as each fire left unattended in a building is a potential " burn out " of that and possibly neighbouring buildings, it is obvious that this weapon will prove most disastrous to property.

There are several types and sizes of incendiary bombs. The well-known is the Light Magnesium (Electron) bomb weighing 1 kilo. Two, twelve and twenty-five kilo bombs are known but are likely to be aimed at special targets. It is, however, considered possible that 2-kilo bombs might be used in indiscriminate bombing.

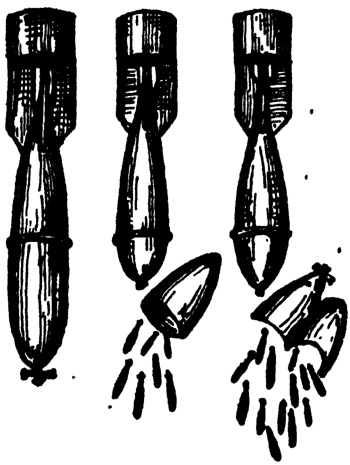
Multiple effect bombs have been designed for use against store yards, large factory buildings and ammunition dumps, etc. They contain a number of separate incendiary units of magnesium or phosphorus which are expelled from the bomb and scattered over a wide area. The incendiary units are small and have little penetrating power but the main bomb weighs over 12 kilos and its steel nose can perforate strong roofs.. Magnesium could be dealt with as in the case of the 1-kilo bomb but phosphorus is more

[1] The following account is based on A.R.P.H.9 "Incendiary Bombs and Fire Precautions".

difficult to deal, for it re-ignites after drying, when extinguished with sand or water. Until all the material is removed, the surrounding must be kept wet and the process of removing it may poison and burn the skin if it comes in contact with it. Thermite bombs in which the entire incendiary charge consisted of the material, were used in the last war. Though its heat is intense it burns rapidly and incendiary effect is smaller than that of magnesium.

Petrol bombs are not considered likely because the five and 10-kilo types used in the Great War were not found very effective. Sodium and Sodium potassium alloys are difficult to deal with water, but can be easily extinguished by dry sand, and are poor incendiary agents. They are also not considered likely.

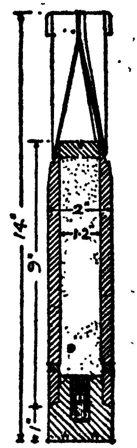
Incendiary bombs weighing about 40 lbs. have been used by the Japanese over Burma. They explode on impact, scattering around a number of pencil-shaped incendiaries 4 to 6 inches long. Every one of them is capable of setting effective fire. Another type contains round black rubber balls which roll away into different parts of a building when the bomb bursts. They smoulder and set fire to inflammable material in contact with them. These balls cannot be extinguished by water; they can be temporarily smothered by it, but when they become dry, they smoulder again. This is a dangerous type; for, until they are searched and removed from a building, the risk of fire is not eliminated. They can, however, be smothered with sand and removed by shovel and allowed to burn harmlessly.



Molotov's bread basket. The Nazis have used this over England recently. It is about eight feet long and three feet in diameter. Many incendiary bombs are packed in a hollow cylinder which detaches midway and scatters them over the target[1]

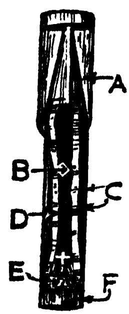
[1] A new type of "bread basket" with small high explosive instead of incendiary bombs is believed to have been dropped by a German raider in one of the outlying London areas during one night. The residents reported that sixteen bombs exploded in less than a minute.

A combination of the high explosive and incendiary bombs has been made in Russia. This weapon was used over Finland with deadly effect. A large high explosive bomb halfway down to the target breaks and releases a number of incendiary bombs which scatter all round. The high explosive bomb contained in the other half of the missile hits the target and explodes.



Typical Kilo Magnesium (Electron) Incendiary Bomb

Since the main objective of an attack by incendiary bomb is the starting of more fires than can be dealt with by the available fire brigade services, authorities are certain that the 1-kilo magnesium electron bomb will be largely used.[1] It consists of a thick-walled tube 9 in. long and 2 in. in diameter, made of an alloy of magnesium with a small proportion of aluminium. On one end of this tube there is a tail 5 in. long to steady the bomb in flight. The tube is filled with a priming composition, of the thermite type. The bomb is fitted with an igniter which may be situated either in the nose or in the rear end of the tube.



The bomb weighs about 2 lb. 2 oz. and with the exception of a few ounces in the tail and igniter, there is no dead weight, the whole being incendiary material. The bomb functions on impact. It does not explode but burns fiercely, the priming composition for 40/50 seconds at a temperature of 2,500 degrees centigrade. This ignites the magnesium tube and the molten magnesium burns for 10 to 15 minutes at a temperature of about 1,300 degrees centigrade and will set fire to anything inflammable within a few feet.[2]

[1] 1-Kilo incendiary bombs are showered in thousands. In the brutal attack on Coventry hundreds of tons of incendiary bombs were showered indiscriminately. When Plymouth was blasted an incredible number of incendiaries were dropped at the start. There must have been many thousands, for it is said that they came down like hailstorm. It is estimated that within the first quarter of an hour 10,000 incendiaries were dropped. The R.A.F. dropped 20,000 incendiaries over the port of Bremen one night.

Some German incendiary bombs "shoot about like jumping crackers". Nazi pilots have also released oil bombs.

[2] Incendiary bombs are also fitted with a new terror device that shoots about and spreads the fire. They were used during the aerial bombardment of Brussels in May. 1940.

Pieces of molten magnesium may be thrown as far as even 50 feet during the first minute when the priming composition burns violently. The thermite composition contains its own oxygen, and cannot be extinguished by smothering while the magnesium depends for its oxygen, upon the air or surrounding materials, in order to burn. One large bomber could carry between 1,000 and 2,000 of these very light bombs, which would probably be dropped from a considerable height, so as to increase their velocity. They would not be dropped singly but would be released from containers each holding 10 or 20 bombs. Several may be released simultaneously. The bomb has very poor ballistics and cannot be aimed accurately. They spread out as they fall, and a group of bombs dropped simultaneously from 5,000 ft. would cover an area of about 100 yds. square.

Unlike the high explosive, incendiary bombs will not strike the target at an angle. Owing to air resistance they come down perpendicularly and hit the roofs of buildings.[1] Bombs dropped from a height of about 15,000 ft. would hit the target at a velocity of 400 ft. per second if it is of the 1-kilo variety. An idea of the penetrative capacity of incendiary bombs of various weights can be had from the following table giving the minimum thickness required for protection against penetration by impact.

Bomb	Reinforced concrete	Sand*	Earth*	Shingle*	Mild steel plate
1 Kilo ..	3½″—4″	6″	6″	6″	¼″
2 ,, ..	5″—6″	3′ 6″	5′	—	⅜″
5½ ,, ..	—	4′ 9″	7′	—	—
10 ,, ..	—	6′	9′	—	1″

*Approximate. 1 Kilo=2⅕ lbs.

The incidence of fires depends upon the speed at which the bomber is flying, the quickness at which the bombs are released and the height from which they are dropped. For instance, flying in a straight line, at 200 m.p.h. at a height of 5,000 ft. or over, and releasing 20 bombs per second, the bomber would drop its 1,000 bombs in a little under 3 miles and would start one fire every 60

[1] *Vide* Felix Samuely. "Protective measures against Incendiary Bombs." The "Builder", Dec. 1, 1939, pp. 755-757.

or 70 yds. The number of fires would be very large since attacks would be made by formations. Assuming that the built-up area is about 15 per cent. of the open space, as is the case in Great Britain, one out of every 6 bombs dropped might hit a building and the others might fall in gardens, streets, yards, etc. A bomber carrying 1,000 bombs can secure 166 hits. Half of them might either glance off sloping roof, and not penetrate or penetrating might fail to function. The remaining 83, that is approximately 8 per cent. of the bombs dropped, would probably cause fires. Assuming the bomber flies in a straight line as noted above there might be one fire for every 60 or 70 yards.

In the absence of persons to deal with them immediately and effectively the fire brigades cannot cope with them. It will penetrate any ordinary roof (including tiles, slates, corrugated iron, and patent roofing materials, even though on close wood backing). But as it is not designed for great penetration it is likely to remain in an upper storey, and start a roof fire which is probably more difficult to deal with, than one on lower floor, since attics and roof spaces are usually less accessible and not so easy to move about in.

Molten magnesium may run through the cracks in the boarded flooring if any, immediately below the roof. The bomb will burn through into the ceiling below and roof timbers 2 or 3 feet above the bomb, may also easily catch fire by its radiated heat. Floor boards 7/8 inch thick, may be burnt through in four or five minutes and lead would be melted almost at once. Corrugated iron (20 gauge) is proof against burning, but if during the burning of the composition a vent-hole of the bomb is against the sheet, the blow pipe effect may cause a hole. Also the sheet will get red hot and if in contact with the floor boards may set them on fire.

It is difficult to deal with this bomb. Sand does not extinguish the bomb, but by cutting off the supply of free air would cause the bomb to burn less fiercely and the glare and radiated heat are reduced. But the metal would still be burning underneath the sand and, if left, may burn through floor boards in a few minutes:

Pouring water from a bucket or can, does not help. In fact it is dangerous and should in no circumstances be attempted because the effect is not to extinguish the burning magnesium, but to cause an accelerated combustion, so that the magnesium, instead

of burning in the ordinary way by combining with the oxygen from the air, obtains an increased supply of oxygen from the water. The hydrogen of the water is set free, and burns in the air.

But if a jet of water is turned on to the bomb, the effect will be to scatter the burning magnesium, a piece of which might hit the operator. The intense heat when the thermite burns makes it difficult to approach the bomb and it is advised that we must be not less than twelve feet away to minimise the risk to person while using the spray pump recommended to bring down the effect of the bomb and to avoid scattering and help the magnesium to be consumed in one or two minutes.

To prevent conflagration, the situation should be tackled as soon as possible, after the bomb has functioned. To deal with a bomb three people may be required; " one to take the nozzle, the two others to work the pump and keep up the water-supply; but two persons can manage quite well and even one might be successful if the situation were tackled very promptly."

For every bomber carrying 1,000 bombs it may require 83 $\times$ 3 or 249 persons and for a squad of 20 such bombers we may perhaps require about 5,000 persons! If there is mass attack with incendiary bombs a large proportion of the city population would be needed to deal with them and they must be in their homes and not in shelters fearing the high explosive!

Half-kilo bombs are also considered likely for they are as good incendiary agents as the kilo variety and since the bombers can carry double the number, the spread of conflagration will be quicker and more serious. In fact this is even believed to be the secret weapon which Hitler announced to the world.

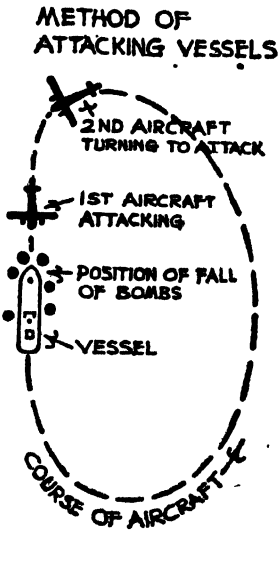
To congested cities incendiary bomb attack is extremely dangerous and towns in the tropics are particularly vulnerable. If broadcast over a city after driving the people into shelters by high explosives the consequences will be disastrous.

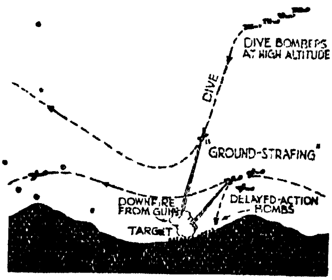
Machine-Gun

Machine-guns are fixed to bombers and fighters and are used to harass the enemy. Defenceless people on land and sea, moving vehicles and trains, and even buildings and structures are machine-gunned. Russian bombers machine-gunned peasants and farm

servants in the villages of Finland, and in many cities 'the raiders machine-gunned the civilians.' Solitary pedestrians and vehicles on roads were machine-gunned. Moving trains laden with passengers have been mercilessly machine-gunned in Poland and China. Nazi pilots have machine-gunned pedestrians in the streets of London, and Japanese, the people of Malaya and Burma.

Machine-gunning of trawlers and fisher folk in the North Sea by Nazi raiders was almost a daily occurrence. Harrowing tales have been recounted by lucky folk who escaped machine-gunning. The planes swoop down from the clouds and machine-gun the deck and the crew. In one of the most murderous attacks ever



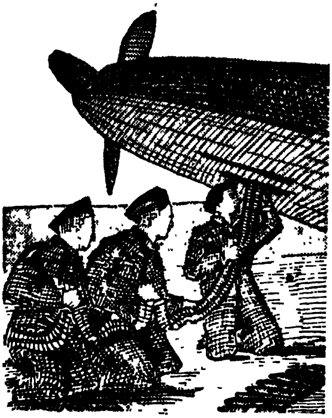


Dive bombing

made (over a Trinity House vessel), the German planes intermittently machine-gunned the deck for half an hour injuring 32 men, some seriously and one fatally. Women and children were machine-gunned in the streets of London.

Children going to school in English Coastal towns have been machine-gunned, as also village schools. While firemen and A.R.P. workers are busy at their work after a raid, Nazi pilots have swooped low out of the sky and raked the area with their machine-guns.

Standing trains in London stations have been thus attacked. Once when a raider swooped down and machine-gunned a train, some of the bullets smashed through the roof but there were few people in the train and nobody was hurt. A running passenger train was once thus attacked. Passengers clearly heard the bullets striking the roofs of the carriages; the train proceeded to a suitable spot and the occupants took cover.



Machine-gun bullets being loaded into an aeroplane

German raiders have also machine-gunned lighthouses, the bullets rattling on the domes and smashing the glasses.

To a vast country with poor defences and unarmed people this method would prove very effective to break the morale of the nation. It is less expensive, but at the same time equally frightful.

Aerial Torpedo

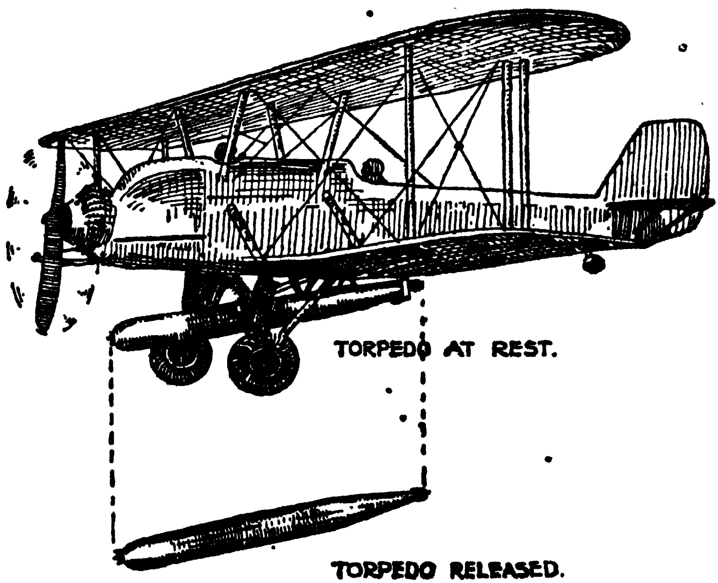
Torpedo attacks are also made from the air, by a special type of torpedo carrying air-craft. The torpedo, similar to that used by submarines and surface craft but of a smaller (18-inch) type, is slung beneath the fuselage of the air-craft, with the nose between the landing wheels. Approaching the ship at a great height to avoid detection, the torpedo bomber dives and throws his torpedo into the sea from a height of less than 100 feet, and within a thousand yards of the enemy ship. As the torpedo is released, a trigger starts the motor that drives it.

The torpedo is more deadly than the bomb. British naval planes had sunk four Italian warships with three torpedoes in a certain roadstead. The attack was carried out in daylight and there were no British casualties.

Taking off from aircraft-carriers, the planes of the Fleet Air Arm carrying torpedoes and bombs, were sent into closely protected

harbour at Taranto. There in the face of anti-aircraft fire and barrages from the Italian warships themselves, the British planes dive-bombed flying as low as 200 feet to launch their torpedoes in water. Only once before has a battleship been torpedoed from air.

Torpedoes were chiefly used hitting the Italian warships at Taranto, below the thinly-protected waterlines. The bombers swooped down, pulling straight at 50 to 100 feet over the water as they released the torpedoes towards the darkened sides of the battleships and cruisers.



Aerial Torpedo

The aircraft-carriers, *Eagle* and *Illustrious*, stole under cover of darkness almost to the mouth of the Gulf of Taranto. The torpedo-bombing aircraft were hauled up to the flight deck. Attack was delivered by as many planes as could possibly concentrate on the target at one time.

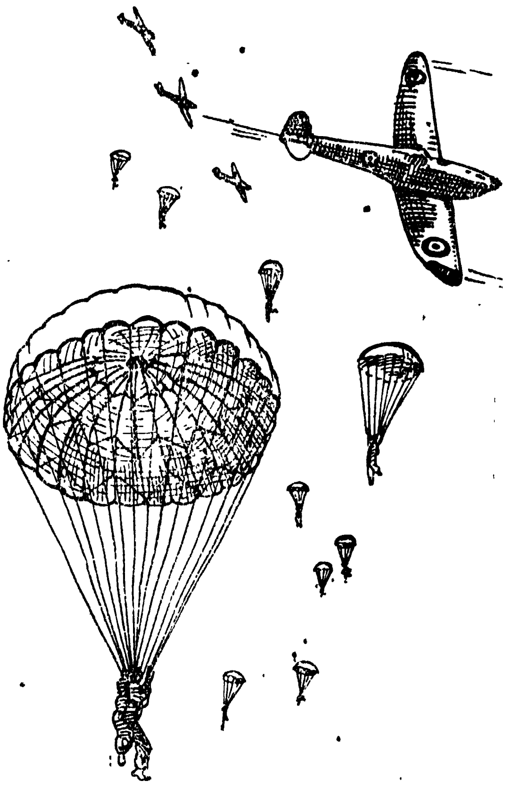
All but two of the attackers made a happy landing on the mother-ships in the first major aerial torpedo attack in this war.

It is true that none of the Italian ships is reported to be sunk but the damage done has been considerable.

Many successful torpedo attacks have been made on enemy supply shipping by aircraft of the R. A. F. Coastal Command.

The terrific power of the aerial torpedo would become clear when we remember that the mighty battleship *Prince of Wales* sank in less than an hour when Japanese planes torpedoed it.

Sometimes aerial torpedoes are released over land targets and great havoc results from its explosion; for instance during August



Method of dropping parachute flares and troops from a plane

1940 an enemy bomber dropped an aerial torpedo on a south-east town in England reducing eight of a row of working class cottages to debris and partially wrecking others. It is feared that a number of people were killed; it fell in the road and burst the water-main.

Poison Gas [1]

Poison gas is another weapon used in air raids. Italy used mustard gas extensively in Abyssinia and her victory at Ashangi is attributed to the spraying of the shores of the lake with mustard gas. So very distressing is this form of attack that the use of poison gas in war was forbidden by the Geneva Gas Protocol of 1925. All the most important countries of Western Europe were parties. But no one doubts the possibility of its use to-day. Every one in vulnerable areas has been supplied free with a respirator, by the Government of Great Britain and the extensive anti-gas precautions taken in that country, indicate the danger.

By the term "gas" in warfare is meant any chemical substance, whether solid, liquid or vapour, which is used because it produces poisonous or irritant effects on the human body.

They are liberated in the air as vapours or irritant smokes, and mix in the air and produce their harmful effect upon unprotected persons who are exposed to this atmosphere. Mustard gas and like substances cause serious effect either by direct contact or with objects which have become contaminated by the liquid.

Some of them form clouds of gas or smoke which drift along the wind, for instance, chlorine, phosgene and arsenic compound smokes. Mustard gas or other blister gases are usually liquids which evaporate slowly giving off dangerous vapour until all evaporate, and the contaminated objects will give rise to skin burns until decontaminated. While the latter persists the former do not and are less dangerous. In congested areas persistent gases do greater injury.

The more important war gases likely to be used are:

1. Tear gases:
   (*a*) Chlor-aceto-phenone (C. A. P.) (non-persistent).
   (*b*) Ethyl-ido-acetate (K. S. K.) (persistent).
   (*c*) Bromo-benzyl-cyanide (B. B. C.) (persistent).

[1] *Vide* A.R.P.H.1 "Personal Protection Against Gas."
A.R.P.H.4 "Decontamination of Materials."
A.R.P.H.12 "Air Raid Precautions for Animals."
"The Protection of Foodstuffs against Poison Gas." Home Office Pamphlet.
A.R.P.M.3. "Organisation of Decontamination Services."

2. Nose irritant gases :
   (a) Di-phenyl-chlor-arsine (D. A.) (non-persistent).
   (b) And similar compounds such as di-phenyl-amine-chlor-arsine (D. M.) and Di-phenyl-cyano-arsine (D. C.) (non-persistent).

3. Lung irritant gases :
   (a) Chlorine (non-persistent).
   (b) Phosgene (non-persistent).

4. Blister gases :
   (a) Mustard gas. (BB'-di-chloro-di-ethyl sulphide) (persistent).
   (b) Lewisite (B-chloro-vinyl-di-chlor-arsine) (persistent).

The tear gas has immediate effect upon the eyes causing intense smarting, a profuse flow of tears and spasm of the eyelids which generally make it very difficult for the person to see. The liquid gas may cause permanent injury to the eye but generally in pure air the effects of the vapour soon pass off. Chlor-aceto-phenone (C. A. P.) (non-persistent) has an irritating effect upon the exposed skin in high concentrations while Ethyl-ido-acetate (K.S.K.) (persistent) is a respiratory irritant also.

Nose irritant gases produce intense pain in the nose, throat and breathing passages during the exposure to the gas but these painful effects soon pass off in fresh air. They are non-persistent and no permanent injury results when the patient is removed into pure air after an attack.

Lung irritant gases otherwise called choking gases attack the breathing passages and the lungs. Chlorine and phosgene will produce death if breathed in sufficiently large quantities. They are non-persistent and a good wind can dilute them and blow them away.

Blister gases cause intense irritation or burning of the skin according to the amount of gas which has come into contact with the affected part. Deep and extensive blisters may be caused in severe cases. No immediate pain is felt on contact with the mustard gas in the solid, liquid or vapour form, but the effects become apparent a few hours later. It also affects eyes and lungs but

symptoms appear after sufficient attack. It is this absence of immediate effect which constitutes one of the greatest dangers of the mustard gas. The need for protection is not appreciated until too late.

Mustard gas is an oily liquid probably dark brown in colour and the substance is readily soluble in certain liquids such as oils, benzene and methylated spirit, and also in tar and fat. Owing to its solubility in fat, it is quickly absorbed by the skin. It is also readily absorbed in the tar surfaces of roads. It evaporates slowly at ordinary temperature and is very persistent. The liquid is more dangerous than the vapour when it contacts the body. Mustard gas is dangerous in a number of ways as shown below.

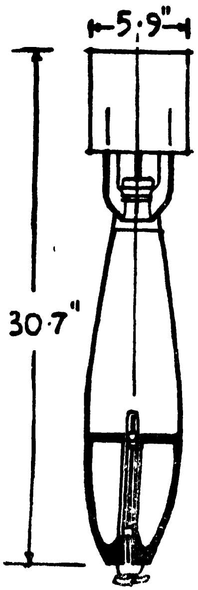
Its vapour given off by the ground or other objects splashed with the liquid, may injure the eyes, the lungs or exposed parts of the body. Clothing may absorb the vapour which will penetrate the skin and cause burns. Touching the contaminated ground or splashed object by the hand or other parts of the body will cause burns unless immediate precautions are taken. Contaminated persons or clothes are dangerous, for the vapour arising from them will affect others. Persons may also be contaminated by mustard gas spray directly.

As already noted neither liquid nor vapour produces any immediate recognisable sensation or effect. " The symptoms do not become apparent for from two to eight hours afterwards by which time it is too late to prevent injury."

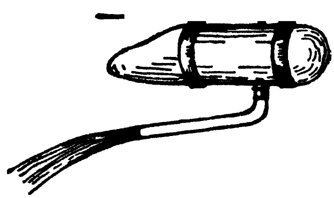
It will also affect the eye seriously even if present in small quantities in the atmosphere. Liquid contamination of the skin needs immediate treatment for the effect will be serious. Even the vapour will burn the skin and if the concentration is high will blister it. Lewisite contains arsenic, has a strong smell, acts more rapidly than mustard gas and is noticed at once. Otherwise its characteristics and effects are generally similar to those of mustard gas.

The effects produced by any war gas depend on the amount of the gas and the length of time a person is exposed to it. The stronger the gas the greater will be the injury produced in a given time. Lung irritants need a certain amount of breathing before their effect becomes dangerous.

There are two methods of using poison liquid gas; by bombs from air-craft, by sprays from air-craft. Air bombs are particularly suitable for charging with gas because they do not have to



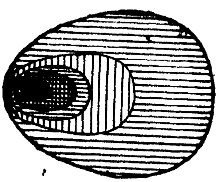
The combined high explosive and liquid gas bomb



Container attached to the plane for spraying liquid gas

withstand the shock of discharge from a gun. Gas bombs range up to 500 lb. in weight and the quantity of gas which a bomb will hold is somewhere about half of the total weight of the bomb. They explode over the surface, and not deep underground and liberate the gas. If it is non-persistent gas a cloud will form at the site of explosion and will drift with the wind becoming more and more diluted ultimately becoming harmless. A high wind may blow them away but also into places where it would not be otherwise. Generally speaking, however, the danger to be anticipated from a non-persistent gas will be very much reduced by high wind.

If there should be no wind at all, only a slight drift, the worst situation will arise, though the effects will be more local. A dense cloud of gas will form at the point of burst and will remain in that particular area until it is gradually dispersed. It will find its way by diffusion and ventilation current into areas, cellars, tunnels, etc., and once there, it is not so readily cleared as the gas in the open streets. Once the gas has penetrated into a confined space it is not subject to the influence of the wind and air currents prevailing outside, and may continue to be dangerous when the outside air has become clear of gas.



The spreading of poison gas

Production of gas from a generator contained in the bomb is also anticipated which will produce greater concentration over larger area.

Bombs containing mustard gas and other persistent gases, make a large splash of liquid at the place where the bomb is dropped and will also cover a considerable area with fine droplets. The size and type of bombs as well as the nature of the ground and the strength of the wind, determine the degree of contamination and the extent of the area affected. The liquid drops or splashes will cause serious injury to the body of men unless immediately attended to. Persons walking over gas contaminated ground will be liable to contaminate their boots by stepping in the liquid or picking up mud containing mustard gas. This danger will persist for a long period (usually some days) unless the area is decontaminated.

Unless the weather is very cold the contaminated area will continue to give off vapour until it has been decontaminated. Tear gas bomb will act similarly. Evaporation of the liquid on the ground will render a large area intolerable, and the vapour effect will continue for a number of days until decontamination is effected.

Small bombs will contaminate a large number of centres and are more difficult to locate and clear, while large ones may produce heavy concentration but in few areas only.

Mustard or other persistent gas can be sprayed from air-craft. The liquid falls in fine drops over a fairly wide area. The drops may indeed be so small as not to be noticed by persons upon whom they may fall. Such a spray may be a source of very great danger, because it may fall on the face, neck, and any exposed parts of the body, in addition to the clothing, without being noticed. Although there are difficulties in these methods the risk to persons in the open cannot be ignored but the danger may be avoided by remaining under cover.

The horrible nature of gas attack to personnel would become apparent when we realise that a respirator cannot protect men, for,

it can be effective for about 4 hours only in contaminated atmosphere, and even during that time it can protect only the eyes, nose, mouth and lungs leaving other parts exposed to the dangers of mustard gas liquid and vapour. Even a full decontamination dress cannot help because "the protection against blister gas vapour afforded by the heavy anti-gas suit is of limited duration, owing to the suction effect produced by movement."[1]

Poison gas also affects food and clothing, buildings and structures, roads and public utility services, rendering them dangerous and unfit for use until proper measures are adopted. The danger to these mainly arises from the persistent gases, and is caused by splashes of the liquid or wind-borne spray. Temporary contamination may also be present in the disturbed earth of the crater of a bomb containing a non-persistent gas.

Food stored in the ordinary way is liable to be contaminated, and must be thrown away. Otherwise gas-proof packing will have to be resorted to for the entire area liable to be attacked. Clothing contaminated by liquid gas cannot be used unless boiled in water for one hour minimum, keeping the garments fully immersed. If they are greasy they should be boiled for two hours. Cotton and linen fabrics need half this time by this process. Anti-gas clothing and oil skin needs boiling for half an hour, gum boots for 2 hours. The civilian respirator cannot be made serviceable after liquid contamination.

To buildings and structures contamination may happen in three ways.

1. Fine spray from air-craft.
2. Gross spray from low-flying air-craft.
3. Heavy local contamination from gas bombs.

The degree of contamination depends upon the surfaces on which they fall. In an absorbent surface, they will penetrate it and take correspondingly longer to evaporate naturally or to be removed or neutralised artificially. The blister gases are of oily nature and are readily absorbed by other oils, by fats (in the human

[1] T. J. Muirhead, "Air Attacks on Cities".

skin) and by tar products (road surfaces). Bricks, stone and concrete also absorb the liquid.

All our buildings and structures are, therefore, liable to be contaminated and rendered unfit for use. Decontamination is not easy for not merely ample water-supply is needed, a suitable way of draining away the washed water is also necessary. If it is allowed into the underground drain, the walls of the mains and crevices may get affected and remain so for a long time. Weathering may take unduly long time in congested areas.

Probably the greatest risk is from the use of a persistent gas such as mustard gas in conjunction with high explosive bombs. Material damage will be produced by the high explosive; and the mustard gas, whether used as spray or in bombs, will render the task of rescuing and treating casualties more difficult and hazardous.

Road surfaces and vehicles readily absorb mustard gas, and transport services could easily be dislocated. Overhead telephone wires are affected by gross contamination of mustard gas. To underground systems too a gas attack is dangerous, especially when a high explosive bomb containing mustard gas penetrates the road surface and shatters the mains. Immediately attending to it would be almost impossible because of liquid gas splashes and the supply could be dislocated. Gas contamination might also be carried along the mains by water.

Particularly in the tropics gas attack will be most distressing because of congestion and heat which will vapourise the liquid rapidly resulting in very heavy concentration of poison in the atmosphere.

Liquid gas affects animals as well; and cows and bullocks and horses and other transport animals are liable to be affected particularly by blister gases, whose injury would require weeks to heal.

Animals are affected by mustard gas and lewisite, by choking gases like phosgene, but nose gases are not fatal to them and fresh air will cure the sneezing. They are not affected by tear gas. Even fodder exposed to the true gases, arsenical smoke or the vapour of blister gas may become unpalatable. No satisfactory animal gas mask has been yet produced.[1]

[1] A.R.P.H.12.

Liquid mustard gas causes deep ulceration after sometime and healing takes 8 to 10 weeks. When animals walk over contaminated ground, their legs are injured. Mustard gas liquid falling in the eye may injure it and it may take some months to heal but heavy contamination may blind them. Grazing contaminated pasture will ulcerate the digestive tract. Mustard gas vapour unless in very high concentration or prolonged exposure will not injure the skin of the larger animals but mustard gas vapour will affect the eyes for weeks as well as the respiratory tract which may prove fatal.

A gas attack is, therefore, considered most distressing and efforts to prohibit the use of gas were made, with results, well known. Its use in Poland and Finland is suspected and the British Government expects it any day, indicating unmistakably the need to get prepared to meet this danger whenever national security is threatened by the air arm. In India too Government are taking steps to ensure that the whole population is in a full state of preparedness against gas attacks.

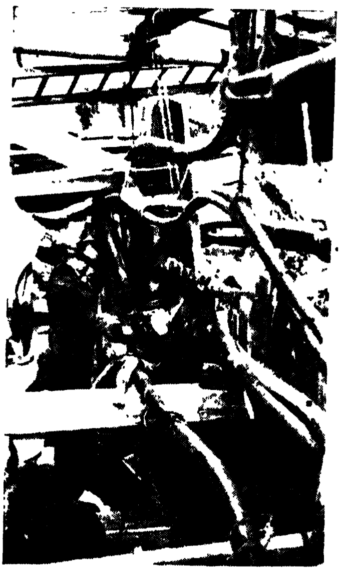
Air Raid Destruction

Abundant evidence has accumulated in recent years proving the destructive capacity of these weapons and the disastrous consequences of air raids.

All these weapons are used and the mode of attack is carefully planned according to the strength of the ground defence and fighter squadrons of the enemy. We are now familiar with mass raids, attacks by relays of bombers, high level and dive bombing attacks, daylight and night raids, nuisance and terror raids and so on. Bombers have come escorted by fighters and fighter air-craft too have harassed the people below. Sometimes bombers have swooped down upon a city from all directions to destroy it and some times they have carried out destruction from a height of even four or five miles.

Flares, incendiaries, and high explosives have been used in succession, but the high explosive has preceded the incendiary. Machine-gunning has been combined with dive bombing and even aerial torpedoes have been used over land targets. Normally in a night raid incendiaries have been used to start fires, and provide

What a German fire raid did for the Paternoster Square in London

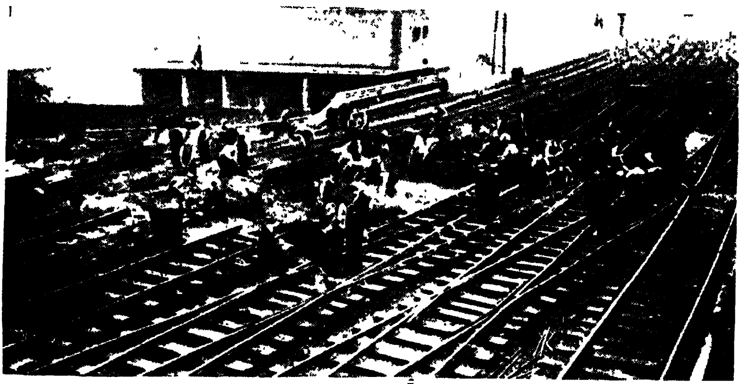


A crater created by a H. E. bomb in London showing the damaged underground telephone cables

An Anderson Steel Shelter

The famous Carlton Hotel, London, which received a direct hit from a H. E. bomb

What the blast of a bursting bomb did to a stationary bus in a London street



Three tracks of the London and North-Eastern Railway were knocked out by a German bomb

light for detecting important targets. Over them high explosives have been used.

Frequent raids have also been attempted to wear down the efficiency of the A.R.P. Organisation and to break civilian morale. Sometimes cities have had over ten alerts in the course of a day. Indeed Malta had over 600 alerts during the 11 months since Italy entered the war. In April 1941 there were over a hundred alerts.

The scale of attack by aircraft has considerably progressed since the last war. Four hundred tons of bombs were dropped over Great Britain by the Germans in four years but the R.A.F. to-day have in 3 months, August, September and October, 1941, dropped over 10,000 tons of bombs, chiefly in Germany and German-occupied territory in spite of the very bad weather of late summer and autumn. Over 300 attacks were made in October alone by aircraft of the Bomber Coastal and Fighter Commands. Some 30 ships have been sunk or seriously damaged in these attacks.

During sixteen months R.A.F. dealt 1,522 major attacks on German war bases up to 1-1-41 ; Hamburg on 61 occasions, Bremen 52, Wilhelmshaven 36. The heart of industrial Germany, the Ruhr District, suffered 500 raids, including 82 on the marshalling yards at Hamm.

"In 5,000 attacks on targets from Channel ports to the Dodacanese Islands in the past eight months, the R.A.F. have spread destruction in Germany, Italy and the territories they command which this Christmas should remind the Axis dictators....Two hundred and fifty raids aimed at air-craft and munition factories have undoubtedly interfered to some extent with Germany's attempt to make up for the terrible wastage of the *Luftwaffe*. There have been 866 large scale attacks on docks, shipyards and shipping in harbours, including relentless and persistent blows at invasion bases, 683 on rail, road and water communictions and incidentally 1,123 on German aerodromes. These daring and dramatic attacks were dealt with on the country stretching from all along the European coastline to deep into Poland. Apart from the heavy damage inflicted on Germany the Nazis have lost 109 air-craft shot down during these operations over their own territory."

During May, June and July 1941, the R.A.F. made 599 raids on Germany and German-occupied countries. Although

slightly fewer raids have taken place on Germany itself, it is now revealed that out of approximately 1,58,000 bombs 100,000 have been dropped there.

On January 22, 1940 a raid on Willemsoord was made by a squadron of Hudson air-craft of Coastal Command and it lasted less than a minute. Nearly five tons of heavy and incendiary bombs were dropped. Besides two ships sunk and another badly damaged, an oil storage depot was set on fire. Naval storehouses were destroyed. German machine-gunners were machine-gunned !

Between June 16 and July 10, 1941, in twenty-four days, the R.A.F. dropped over 2,000 tons of bombs in the Ruhr area, 1,000 tons on Cologne and over 500 tons on Bremen. During one month in 1941 the R.A.F. dropped about 37,000 bombs on Germany and German-occupied territories. The Nazi pilots have poured out 200 tons of bombs over London during one raid.

Thousands of tons of bombs have wrought havoc in Germany's two other greatest munition areas set deeper inside her western frontier. One is a hundred miles higher up the Rhine bounded by Frankfurt-on-Main and Stuttgart with Mannheim at its centre. The other is the Leipzig area some two hundred miles east of the Ruhr. Both continue to be heavily punished.

In the Leipzig area Leuna and Magdeburg, two of the most important centres of the synthetic oil industry have suffered some of the heaviest attacks made by the R.A.F.

Three hundred and ninety-nine were killed and 461 injured in Britain in June. During the month of June 399 persons were killed, of whom 175 were men, 160 women and 64 children. The injured and detained in hospital numbered 461, of whom 239 were men, 175 women and children 47, under 16 years of age. In addition, 7 persons, all men, are missing and believed to have been killed.

Five thousand and three hundred were killed in May, 6,065 in April. During the first half of this year 18,314 persons were killed by German air raids. In the previous six months the number killed was 23,960.

One thousand people died in Bremen and 7,000 were injured. Berlin's civilians also suffered terribly from bad shelters. Some

of the " big beautiful bombs " to which Lord Beaverbrook recently referred, are massive 2,000 pounders with a devastating effect worse than any of those the Nazis have yet employed.

The R.A.F. has delivered approximately nine hundred attacks on particular target areas, containing one or more different types of objectives inside the Reich proper. Of these seven hundred were made in three months, July, August, and September 1940. In the same length of time upto New Year's day 1941 the total was five hundred.

According to a Turkish traveller who visited Hamburg, Emden, Bremen, Dusseldorf, Cologne and Essen in July 1940 " hardly a single factory remained intact in any of these cities." "Hamburg ports," he declared, "was in ruins."

R.A.F. bombers made 87 raids on Tobruk during the day which preceded the launching of the Army's attack thus playing an important part in the capture of this Libyan port.

The *Luftwaffe* in the first nine months of this war maintained very heavy pressure over Britain. It has caused severe damage in the City of London, blasted Coventry, Bristol, Birmingham, Cardiff, Southampton, Liverpool and other towns and ports. In some places essential communications have been affected and dislocation has been caused to war industries.

London absorbed about 200 tons of bombs one night in what was one of the worst raids yet experienced.

It is officially announced that British Civilian air raid casualties from January 1, 1940 to the end of June 1941 were approximately 41,900 killed and 52,678 injured and detained in hospital.

The Germans claim to have discharged twenty thousand tons of explosives upon Great Britain since the beginning of the war upto October, 1940. They claim that on one day 251 tons were thrown upon London in a single night.

Recent experience proves the effectiveness of air bombardment. It is as General Valle, Italian Under-Secretary for Air, observed in 1939 "beyond all expectations." From the Harbour quarters

of Valencia and Barcelona we can get an impression of how an inhabited area could be reduced to a heap of ruins where no life could exist."

Nazi raids in Poland, Belgium, Holland, etc. have also demonstrated the destructive power of aerial bombardment.

War correspondents in Russia have given us accounts of German air raid destruction over Russian towns and villages. *Reuter's* Special Correspondent in Russia wrote in September 1941 :—

"I saw much wretchedness, I saw many Guernicas. (Guernica was the historic Spanish town destroyed by German air raid during the Spanish Civil War). I saw towns and villages which have been wantonly burnt out by the Germans in their 'terror raids'. In one village which is exceptional, there were a few houses still standing. But the only inhabitants were one peasant, three children and one blind woman who had been rendered insane by the experiences through which she had passed. In another town, Elnia, which formerly had relatively 5,000 inhabitants, the only building intact is one church. The remainder consists mainly of chimney stacks and heaps of rubble and ashes. Even in villages, many thatched roofs had been blown away by blast. There were numerous craters on the roadsides. One town, Dorogobush was completely destroyed by terror raids in July 1941. There were nothing but burnt-out houses showing through all the windows. One large, prosperous village was represented by few burnt stumps, all that remained after a raid."

The German mass raids on the city of Belgrade on Sunday 6th April, 1941 left the city in a mass of ruins. On Sunday morning while the sound of church bells was calling, the bombardment eclipsed in horror all imagination. A veritable deluge of incendiary and explosive bombs turned the city into a mass of ruins and gutted homes while all the streets of Belgrade were covered with bodies of children, women and old men. German planes destroyed most of the hospitals, churches, schools and cultural institutions of Belgrade in broad daylight. The Royal Palace was destroyed by thirty bombs. The German planes even bombed isolated houses killing thus Dr. Koulovetz, the Leader of the Slovene people. German planes machine-gunned women and children fleeing from their burning homes.

Hundred and fifty Dornier and Junker dive-bombers launched the attack at 7-15 a.m. The principal city square was severely hit and victims were numerous. Second wave of raiders appeared at 9 a.m. The central Electric Supply was destroyed and the water-supply was upset and more fires broke out, in the industrial quarter at 2 p.m. A new onslaught followed notably on the centre of the city and not a single pane of glass was left intact. With one house in ten blazing, the whole street was soon destroyed. More raiders came over during the night. The attack ended at 3 p.m. on Monday. By then only a few thousand inhabitants were left. As night came on again, flames leaped from house to house and one could not put them out as the water-supply had failed. Later rain began to damp down the fires leaving Belgrade a picture of desolation, with enormous craters in the middle of the broad avenues, automobiles overturned, houses left frontless, dead bodies strewn in the streets. Over 20,000 civilians were killed and men were living like animals in the city after the raid.

A third of Rotterdam was destroyed by bombing. A communique issued by the Dutch Legation in Paris on May 19, 1940 states that at least one hundred thousand people were killed and one-third of the city destroyed when the Germans bombed Rotterdam. Two squadrons of German bombers flew over the city in close formation dropping delayed action bombs that " ploughed a veritable furrow of destruction." Bombs weighing two thousand pounds were dropped from a height of 4,500 feet. After passing over the town once the planes returned and repeated the operation again and again. Houses and buildings over an area of fifteen to twenty square kilometers—one-third of Rotterdam—were completely destroyed.

It has been calculated that during the eighteen days of German *blitzkrieg* in Belgium 34,000 houses were damaged or destroyed. An additional 16,000 houses suffered to a lesser degree. Nearly 6,000 miles of highways also suffered in the onslaught.

Abbeville has been bombed to pieces in a casual raid.

The Germans in May 1940 on their way towards the Channel ports bombed Abbeville to pieces. It was one vast desolation of smouldering ruins with shattered streets strewn with dead and dying women and children. They bombed it apparently without thought

of military objectives, dropping high explosive and incendiary bombs and incendiary darts.

The first air raid on Warsaw took place at 6 a.m. on September 1, 1939. On September 18, after the German ultimatum to the city to surrender was rejected began the systematic destruction of the city by the artillery bombardment and air bombing which lasted uninterruptedly for ten days. By September 24, all public utility services were dislocated; the city lacked water, electricity and gas, and bread became scarce. The Germans increased the intensity of their bombing and the bombardment which they maintained for three days which came to a climax on September 27. Next day the Warsaw Command, lacking all means of defence, capitulated. On October 2, the German Army entered Warsaw. Poland became the city of ruins, graveyards, hunger and disease in the words of Prof. Strongski, the Polish Minister of Information.

The German attacks upon the civil population have been concentrated mainly upon London in the hopes of terrorising its citizens into submission. During the first half of September 1940 about two thousand civilians, men, women and children, have been killed and about eight thousand wounded by air bombardment. Four-fifths of these casualties have occurred in London. Many hospitals, churches and public monuments have been damaged.

Thousands in London, men, women and children, have been rendered homeless by indiscriminate bombing.

Eleven hundred people were killed in the German air raids of March 13 and 14 in the Clydeside area and 1,000 seriously injured.

29,000 people have been killed and 40,000 injured throughout Britain upto the end of March 1941. In 400 hospitals and institutions of all kinds in Greater London the casualties among patients were 235 killed, 195 injured. Because elaborate precautions were taken to meet conditions of a heavy raiding the risk inside the hospitals was less than outside, although many hospitals have been damaged.

Virtually 2,000 churches in London and the provinces have been destroyed or damaged by German bombers in quest for military objectives. The actual number as given by Vatican Radio is 1,986

and comprises: Destroyed in London—14 Roman Catholic, 250 Anglican and 350 Free Church. Destroyed or heavily damaged in the Provinces—20 Roman Catholic, 300 Anglican, 514 Free Church. In addition, 45 Roman Catholic monasteries and convents were destroyed.

Ramsgate in England has been almost razed to the ground. Over 1,200 houses have been destroyed and the entire town rendered uninhabitable. More than 8 churches in London have been damaged including St. Paul's. The famous Cathedral at Canterbury has not escaped.

Even in towns equipped with anti-aircraft defences and fighter squadron, the risk to life is very grave as raids over Malta indicate. Twenty-three civilians were killed and several wounded in one of the raids on June 26, 1940. About 70 bombs were dropped. One bomb hit a bus, full of passengers most of whom were killed. The previous day 12 civilians were killed and several wounded. The bombers were driven off by British fighters and anti-aircraft fire. Destruction would have been far greater if bombers had their way.

The raids on Barcelona during one day succeeded in killing 875 persons (including 245 women and 118 children) and wounding 1,500; 48 buildings were completely destroyed and 75 severely damaged. About 200 persons were killed and 500 injured, most of them being women and children in a Catalan town of 10,000 inhabitants, in one day.

It is estimated that one-third of Madrid's houses has been completely ruined and that half of its houses were damaged. The same is true of many towns in the fighting area of Spain. One can see buildings destroyed everywhere. The railways are in the same condition as the railways of Central Europe after the war. The seats are missing, wood has been torn away for fuel, leather taken for shoes and slippers, the windows have been removed, and there were no lights in the carriages, owing to the large number of engines, trucks and wagons destroyed by gunfire, air raids, and over-use.

In China too, as in Spain, we see terrible manifestations of the destructiveness of bombardments from the air, cities grievously damaged, men, women and children slain and mutilated.

Chinese towns subjected to air raids are not different. Canton Port was destroyed as well as parts of Shanghai and Chungking. During a day's raid on Chungking whole blocks were levelled to the ground.

In the series of raids which began in the end of May, 1938 and continued for a week, the number of killed and wounded among the civil population ran into thousands, although apparently the Pearl River Bridge, the power station, waterworks, railway stations and factories were targets of attack. Three thousand people are reported to have been killed during a Japanese air raid on Lungchow in August, 1940.

According to the Greek Minister for Justice, M. Dimitrakkis, ferocity and savagery with which German airmen devastated the cities of Crete were "indescribable". "Canea, the beautiful defenceless capital of Crete, now is no more" states he "The last I saw of it was a gigantic heap of smouldering ruins. Not a single wall was standing. Its holy Turkish mosques and Greek churches were razed to the ground The Nazi airmen had done their job well, to the satisfaction of their Fuehrer."

The large scale use of gas in recent times comes from Abyssinia.[1] Italy used mustard gas on a large scale. It was first dropped in drums and there is some evidence that, so used, it had no considerable effect. Gas was much more effective when sprays were substituted for drums later on, and one eye-witness attributes Italy's victory at Lake Ashangi to the spraying the shores of the Lake with mustard gas. Air-craft and explosive bombs also materially contributed to the success.

During the six months for which the war lasted nearly 2,000 tons of bombs were dropped. Seventy-four tons were dropped on one day, the quantity German aeroplanes dropped upon Britain in the Great War. Its capacity for harrying a beaten foe was enormous. Three hundred and ninety-six tons of bombs were dropped within four days resulting in 3,000 casualties at the ford of the River Takkazewas.

Hango, Abo, Viipuri and other towns of Finland also reveal the destructive power of air raids, the high explosive bomb and the

[1] See A. A. Spaight.

incendiary. Abo suffered 30 raids during two months of war. Russian raiders dropped some twelve hundred bombs and eight hundred buildings were made uninhabitable. Further, air raids and the threat of attack by air-craft, forced the people of Abo to reverse their mode of life. For over five weeks they worked by night and spent the days taking shelter.

In fact this is the most distressing feature of air attack and its possibility. The strain of the people, the psychological effect of fear constantly harrowing the mind of the old and the young, the women and even animals are far more serious than what is indicated by statistics of deaths and injuries and damages to buildings. The amount of strain caused to people of vulnerable areas could be gathered by the fact that the threat is sometimes never absent for days together. Malta had over 600 alerts during the eleven months since Italy entered the war, which included over a hundred during April 1941. Since Hitler launched his big scale offensive against England during August, London has spent a total period of 1,056 hours, or six weeks, under air raid warnings. The Capital has had nearly 400 day and night warnings, ranging in time from a few minutes to an all-night alert, lasting over 14 hours, which is the longest record so far, although the greater part of the 24 hours has frequently been intermittently under warning. We cannot overlook the " far and wide terrorisation of the populace, women and children, sick and old, especially. The ill-health of vast numbers must be counted in, and the misery caused. The constant obsession of mind with a dead weight of fear to the exclusion of everything else must be reckoned."[1] And above all we must remember that all these happen to people who dwell at home far from the fighting-fronts ; who are powerless to do more than suffer passively the tragedy and the grief. This is evident from the condition of the people of England during the Great War when the threat of air attack hung over them for four years, although air raids were very much less deadly than what they are to-day. In fact more bombs have been dropped in one week recently than the total number that was dropped during the entire period of four years in the last war.

[1] L. E. O. Charlton, " War over England". For the following account see Part I.

The estimated total damage during last war by air raids in England was: 1,414 killed, 3,416 wounded. The material damage was just under three million pounds.[1] About 270 tons in deadweight of bombs fell on British soil throughout the war in the course of 103 raids, air-ship and aeroplane combined. In all some 8,500 bombs were let fall small and great, from the light-weight incendiaries to the high-explosives upto a ton weight. Within two days in January 1940, some 3,000 bombs fell in Finland and within a month, 234 were killed, 264 seriously wounded and 210 slightly wounded by air raids.

Yet the threat of raids made the life of people intolerable. "It was a strange England: strange in city and town and strange over the country-side." For the better part of the two whole years until the air-ship ceased to raid, the whole country lived and suffered under a Zeppelin psychosis.

Full moon days were special nights of terror to the teeming masses of the Metropolis, and dark nights were dreaded when Zeppelins continued to raid. Panic was particularly severe among the foreign folk in the crowded East End. In the shelter of the tube stations the distress of Jewish mothers and children was very difficult to soothe. They would scream loudly, tearing their clothes and beating their breasts, while old men amongst them would pluck the hair from their beards in the fashion of the Scriptures. Too often, bands of young aliens belonging to neutral or allied countries, shedding every vestige of manhood, would behave like animals of the wild, sometimes brutally trampling people to death in a mad, insensate rush for safety.

Nightly, except when weather conditions obviously prevented raiding, hordes of people would slowly progress towards the tube station nearest to their homes and there take up quarters for the night. They would throng the staircases, passages and platforms, occupying every square inch of available space. As many as a quarter of a million would find accommodation in this manner, the able-bodied accompanied by the sick and the halt. In such circumstances babies were born and those at the last gasp died. Sanitation there was none. Food litter lay around, and worse still,

[1] The damages caused by the German bombing of Aalesund alone is estimated at several million kroner.

to add to the squalor of the scene, passengers on the system were sometimes unable either to take train or to alight at their destination, so densely packed was the multitude.

People left London to suburban terminus to camp in the fields till dawn. Groups of people belonging to this superadded local population would behave distractedly, praying for deliverance in camp-meeting style and cursing loudly, with arms extended, the brilliant autumnal moon.

This refers to London the Mecca of the raiders. The same things though in lesser measure happened over half the rest of the country. The eastern coastal fringe was particularly affected, and especially places such as Hull, Tyneside, Edinburgh and Harwich, important objectives and clearly demarcated by their situation at the head of estuaries. In those places also similar scenes of death and destruction resulted from the raids, and there as well murder of the mind conjointly with murder of the body was committed.

In the provincial hospital wards, likewise, babies were born deaf, deformed and blind owing to the terrorization of the expectant mothers. The case of the children was sad indeed and those of tender age suffered cruelly from nerve shock.

At school, the day after a raid the children would be encouraged by their teachers to sleep through the lesson hours so as to restore the nervous strength which the night of terror had dispersed.

False alarm, and numerous were the occasions, had as much force as actual attack in the sense of fear awakened. The harassing effect on old and young alike, of the nightly migrations from the towns to the shelter of mine workings and colliery drifts in the Midlands and North; to the open fields, caves, subterranean passages, and disused chalk pits by the dread of a raid, " is beyond computation."

Black-out had dangers and depressions. Pedestrians could only grope their way home by the light of hand-held electric torches fitfully switched on. Mill-working lasses in the Lancashire cotton factories were in jeopardy for darkness provides an opportunity for the violator. Here and there prosecution resulted for striking matches in the open. The motorist's plight was deplorable if his car headlights were on.

Even the very birds and animals developed air raid nerves. It was for them their war-time malady. Dogs would howl piteously. Cats sought the darkest recesses. In open country cows lowed uneasily and the horses in the fields stampeded up and down. Sheep lamented in the fold. In the coverts and amongst the stubble the birds chattered when they should have slept and noises of alarm came from the pheasant and the partridge. Their alert and animal sense of hearing could detect the hum of engines in the air long before the sound reached the ear of man.

The people " were like patients in a hospital ward. They were reliant on the treatment and the medicines and felt certain they would get well if they did what the doctors told them to, refusing to say ' die.' They were as helpless and as passive."

This grave consequence is not accidental but deliberate. For demoralising the civil population and destroying the morale of the nation is one of the objects of air attack, and raids are planned accordingly.[1] Therefore it is that in addition to aerodromes, aeroplane manufacturing centres, seaplane bases, naval bases, harbours, bridges, railways and other military objectives and nerve centres and sources of production of essential supplies such as electric power-houses, telephone and telegraph centres, reservoirs and dams, hospitals, hospital ships and trains, educational institutions, historic memorials, even frightened civilians fleeing for life are attacked.

[1] During the last two years in England, juvenile crime has shown an increase.

Sir Alexander Maxwell, Permanent Under-Secretary of the Home Office in his first report on juvenile delinquency in Britain since World War II began, has stated that the first four months of 1940, showed 50 per cent. increase in crimes committed by children under 18, chief offences being stealing, breaking into homes and shops.

Manchester suffered a record increase in juvenile crime-wave, namely 77 per cent. over 1939. Of 1,323 children indicted, on criminal charges, 797 were boys and girls of 14 or less. The rest ranged in age from 15 to 17.

If the immediate havoc wrought by the war on children's morals are appalling, the long-range damage it can cause is even greater and practically irremediable. Medical psychologists draw pointed attention to juvenile delinquency which is admittedly and alarmingly on the increase in Britain. The demoralising effect on the impressionable minds of children of the wanton and colossal destruction of property by air attacks is bound to develop in them a spirit of recklessness and destruction, to begin with breaking window and breaking into houses, etc.

Since the war began forgetfulness has increased by 50 per cent. Of the 20,000 gas masks which have been mislaid in London Transport Vehicles, since the war started 4,000 remain " in stock ". There is also a choice selection of tin helmets and torches complete with batteries.

In addition to towns and villages isolated farms and peasants' homes were ruthlessly attacked in Finland by the Russians. Not a single place which the British Labour Delegation saw which had been hit in Hango was a military objective but in many places workers' houses were destroyed completely. The Russian bombers "primarily concentrated on demoralising the civilian population." No more evidence is needed to make this apparent than the machine-gunning of civilian population and unarmed fishermen.

The destruction of property and the dislocation in the supply of services necessary for the normal functioning of the community have also become evident from recent raids. To achieve these aims crowded and congested cities are extremely well suited as experience proves. The three basic constituents of the civic organism, namely, the citizen, the city structures and the supply of essential services, are vitally affected by weapons used in air raids. If poison gas affects men by contaminating the atmosphere and buildings and roads, the high explosive bomb is dangerous because of its blast and splinters and the indirect damage through flying and falling masonry, and the incendiary bomb because of its power for effective conflagration. Liquid gas (persistent) incendiary and high explosive bombs are all dangerous to structures of all kinds normally found. Underground systems, particularly if they are not laid very deep are liable to be blown up by the high explosive if it strikes the road and incendiary bombs can set fire to buses and transport systems as it happened in Finland. The high explosive can dislocate transport services by destroying railways and roads, electric power-houses, and telephone exchanges, etc. A combined high explosive and liquid gas bomb is particularly dangerous to underground mains, and Lewisite gas used in adequate quantities can poison city water-supply sources and render the normal functioning of the community impossible.

CHAPTER II

PREVENTION AND ESCAPE

CHAPTER II

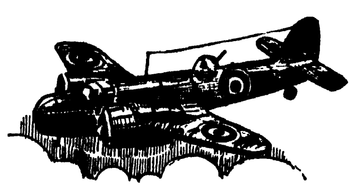
PREVENTION AND ESCAPE

Since the destruction caused by aerial bombardment is terrible, the ideal method of dealing with the air menace would be to prevent the bomber getting through and discharging deadly weapons upon the targets below. No effort is, therefore, spared to concert measures which would prevent bombers from getting through.

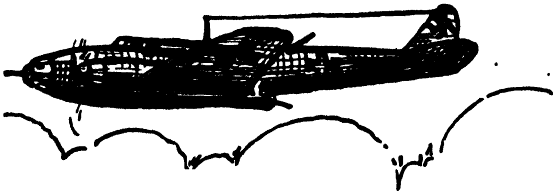
Interceptor planes or fighter air-craft have been designed to chase bombers away and shoot them down. Anti-aircraft guns are erected to throw a barrage of fire and shatter them. Balloon barrages are being used to keep them high and prevent low-flying attack. Measures for escaping the bomber, should it succeed in forcing its way through our defences, are also devised. By ingenious measures targets are rendered inconspicuous to escape attention. Artificial lighting is obscured and the detection of objects made difficult at night. People are removed from vulnerable areas to places of safety and others given protective accommodation.

Fighter Air-craft

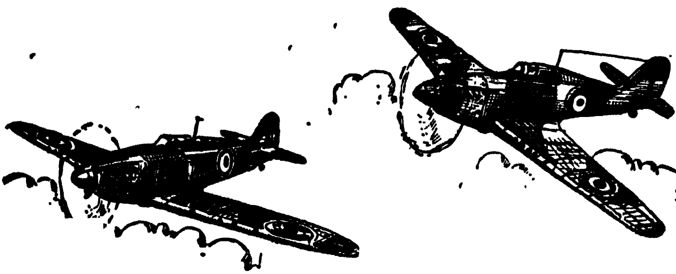
Fighter air-craft are lighter and very much faster than bombers. These form the first line of defence for they are intended to drive the bombers away or shoot them down. The Defiant, Spitfire and Hawker Hurricane of Great Britain are credited with incredible speed. Such planes could chase the bombers, but although speed is essential to chase the bomber, success depends on other factors as well, such as the number of air-craft engaged and the mode of attack, the capacity of the pilots and climatic condition.



The celebrated Bristol "Blenheim" long range bomber. Capable of cruising at 200 m.p.h. for 5½ hours and with a maximum speed of 285 m.p.h. These machines are of all-metal-stressed-skin construction and have a total wing span of 56 feet 4 inches



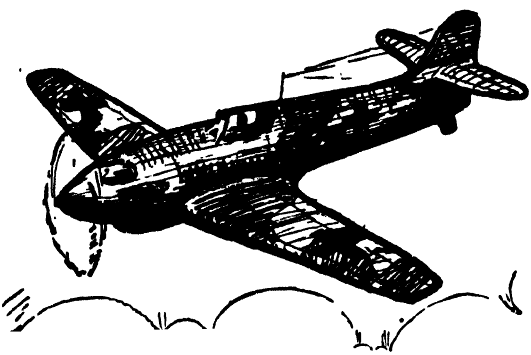
The Heinkel bomber " III K '



Fighter air-craft

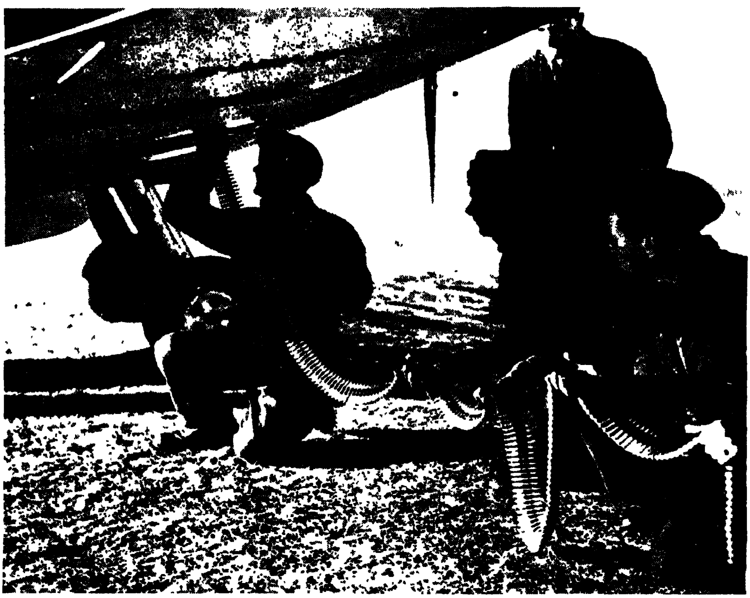
(*a*) The Supermarine " Spitfire " has eight machine-guns mounted at the wings and can develop a maximum speed of 367 m.p.h.

(*b*) The Hawker "Hurricane" single seater fighter has eight machine-guns and can develop a speed of over 330 m.p.h.

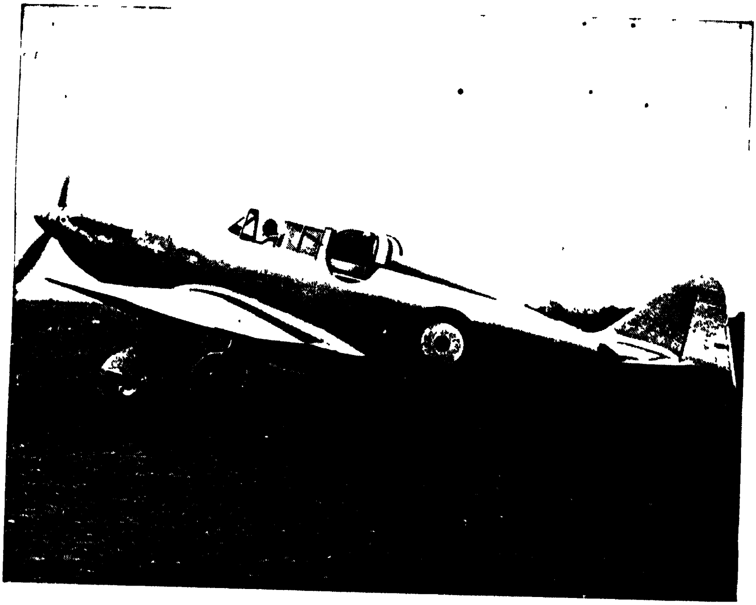


(*c*) The Messer-Schmidt " Me 109 " fighter, considered the fastest air-craft in the world ; has a speed of 354 m.p.h. It carries two machine-guns in the wings, two synchronised machine-guns above the engine and a 23 mm. cannon firing through the boss of the air screw.

Blenheim Bombers



Loading bullets into Machine-guns of Fighter-aircraft.



British Fighter-aircraft 'Defiant'

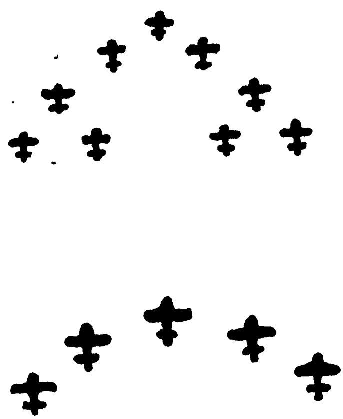
'Hurricanes' on patrol

Expert opinion asserted years ago that an air attack cannot be repulsed and met by the air arm alone. In his book, "Behind the Smoke Screen,"[1] General Groves sets forth his conclusion thus:—

1. Air attack upon cities cannot as a rule be met and defeated in the air;
2. Anti-aircraft guns cannot as a rule be relied upon to bring down aeroplanes;
3. Local defence can only, in favourable circumstances, afford partial protection against aerial bombardment, and then only if it is proportional to the scale of attack;
4. Under weather conditions such as are quite normal in England, local defence may be greatly discounted or entirely useless.

This is because aerial warfare involves action in three dimensions. The vast scale upon which it may be carried on greatly reduces even the chance of air forces meeting and engaging each other. According to Air Marshal Brooke Popham,[2] late Commandant of the R.A.F. Staff College, "Fighting in the Air on a large scale only takes place by accident or by mutual consent."

Major Oliver Stewart, the Air Correspondent of the *Morning Post* and distinguished fighting pilot in the last war supports the view and emphasises the difficulty of locating enemy planes. "In order to pick up aeroplanes from an aeroplane with certainty, it would be necessary to be able to look everywhere at once."[3]



Bombers flying in formation

[1] Quoted in "The Menace of our National Defence," by Sir Norman Angell, pp. 67-68.

[2] *Ibid.*

[3] *Vide* Norman Angell, p. 70.

The air defence of a city does not imply merely the protection of the perimeter of the town, it necessitates the guarding of that area to a height of 25,000 feet. For large cities this would mean the guarding of many cubic miles of air. To find the enemy in this immensity, in any but the clearest weather, may be as difficult as finding a needle in a haystack.[1]

Recent events in Europe have shown that intercepting bombers is extremely difficult. The problem of intercepting enemy air-craft moving at speeds of four miles a minute and upwards at any height up to 20,000 feet and taking advantage of cloud and haze conditions is obviously one of great difficulty.[2] It can never be claimed however thorough the defence system may be that enemy air-craft "would not on occasion penetrate it."

For instance in the North Sea air battle fought in the beginning of January 1940 the "twin-engined multi-gun Messer-Schmidts, latest of Germany's fastest fighters diving with the advantage of the sun behind them, were unable to shake the formation of the British planes. . . . . Even the heaviest close range attacks were successfully beaten off by the British planes, keeping 'shoulder to shoulder' in tight formation."[3]

When the R.A.F. air-craft in the last week of February 1940 attacked warships near Heligoland with bombs "anti-aircraft fire was encountered from ships and shore batteries. One British air-craft was attacked by three enemy fighters without success and it is believed one enemy fighter was forced down. No casualties or damage was suffered by any British air-craft during the opposition."

In another reconnaissance flight over the same territory "one of the British air-craft was attacked by five Messer-Schmidts. Having repulsed the five separate attacks, British air-craft returned home safely after completing their task."

An authoritative description of the air battle states that a British bomber was attacked from above, from the left and from

[1] Major-General Ashmore; quoted, *ibid.*, p. 72.

[2] Sir Kingsley Wood. Reply in House of Commons.

[3] The succeeding account is based on official *communiques* and *Reuter's* news published in the "Hindu", Madras, during Sept., 1939 to June, 1940.

astern by five Messer-Schmidt fighters of 109 type. Despite the enemy's superior speed, and the fact that it was hit six times by machine-gun fire and one of the British machine-guns was virtually out of action, the bomber succeeded in evading its pursuers and returned safely to its base with valuable photographs previously obtained over enemy territory. All members of the crew escaped injury.

Many German raids on the East Coast of Great Britain have been carried out during daytime when fighters failed to make contact. Maybe it is due to mist and bad visibility, the better ability of enemy pilots and the suddenness with which the attack was made; but these factors cannot be ignored. When air-craft under cover of mist attacked with bombs and machine-gun fire merchant ships on the East Coast of Scotland on the 10th January 1940 and dropped a umber of bombs "fighter air-craft was sent up, but owing to bad visibility no contact was made." British planes arrived shortly after two large German bombers attacked a steamer off east coast but the Air Ministry does not know "whether they made contact with the enemy."

"British fighters ascended but failed to make contact" a fortnight later when three planes flew over the Shetlands. The planes dodged behind the clouds and spent nearly two hours flying backwards and forwards across the island. A few days later a Heinkel which attacked an armed British trawler at Great Yarmouth "escaped into the clouds off the Scottish coast after being intercepted by fighters."

"Two German planes bombed and machine-gunned the *City of Bath* off the Firth of Tay. The liner replied with anti-aircraft guns and the planes flew away just before the arrival of three British fighters. After a game of hide and seek in the clouds the planes made a second attack on the *City of Bath*."

Two enemy bombers were observed off the East Coast of Scotland on one morning, during the close of January, at less than 600 feet high with a British plane in close pursuit. The Heinkel bomber swooped down on a patrol vessel, dropped two bombs and made off. "The plane appeared playing hide and seek in the cloud with R.A.F. planes which had earlier driven off another big grey plane. After they had chased the first one out to the sea, the other

appeared further south; the " enemy aircraft .... was pursued by fighter and coastal patrol air-craft with results not yet known."

" Ships batteries, shore defences and fighter aircraft combined to drive off the enemy," says an Admiralty *Communique* which, however, admits that " German aircraft made a raid on the Fleet Anchorage at Scapa Flow. About fourteen enemy air-craft reached their objective. A considerable number of bombs were dropped, one hitting a warship ...."

More than 50 high explosive bombs as well as many scores of smaller incendiary bombs fell in West Orkneys; " despite strong fighter and anti-aircraft defence the German planes carried out their orders successfully."

Bombers come escorted by blocks of fighters on both sides or escorted by fighters circling in front and above them, or by blocks of fighters " stepped up " into the clouds to attack the targets.

The bombing planes approach the enemy area in a tightly packed mass at great heights, about 8,000 feet, " stepped up " in the sky above and behind or successive tiers of escorting fighters. When the enemy fighters approach the bombers the escorting fighters dive down on the intercepting planes while the bombers keep on flying to the destination. Interception by fighter air-craft becomes very difficult.

Moreover fighter-bombers are now used and they are hard to deal with. Fighters are also now used to attack the enemy. The consensus of opinion from Greece and Crete is that low-flying fighters are more deadly than dive-bombers!

German fighters claimed to be incredibly fast, seem to be no more successful. In the course of a daylight reconnaissance of Heligoland Bight on March 16, 1940, British machines bombed a number of German Naval Patrol vessels between Borkum and Heligoland. The next day one British air-craft swooped from 6,000 to a few hundred feet and dropped a salvo of bombs on vessels. The bomber came under concentrated fire of the patrol vessels but was not hit. Other machines encountered anti-aircraft fire and fighter attacks but all returned safely. Why did the British bombers succeed against the faster and heavily armed Messer-Schmidts in the battle in the North Sea in the second week of January 1940? Well-

judged leadership, fighting discipline and steady formation of flying are considered responsible. The bombers were nine Blenheims, flying in formation, at a height of 5,000 feet. When the leader sighted the Messer-Schmidts he closed up the formation and turned off his course in order to lead the Germans further from their bases and dived to sea-level in order to reduce the number of directions from which an attack could be made.

The Messer-Schmidt's top speed is reported to be about 365 miles an hour and they are heavily armed with machine-guns and cannons. "The fight lasted twenty minutes during which the Messer-Schmidts delivered attacks with great rapidity both from ahead, from on the beam and from astern. Despite the simultaneous attack from different directions, the Messer-Schmidts failed to make any appreciable impression on the steadiness of the British formation."

A careful review of the war in the air during the first four months of the struggle, September to December 1939, makes it clear that bombers have successfully escaped fighters. In the words of a well-known authority on matters aerial, "the single-seat and two-seat fighters—interceptors as we call them, pursuit ships in America, *appareils de chasse* in France, and *Jagdflugzeugen* in Germany—have had plenty of practice in all belligerent countries. The comparatively few bombers on each side which have flown over enemy territory have been intercepted and chased by so many defensive fighters that the wonder is that any of them returned.

In some of the bomber *versus* fighter affairs we have discovered that a four-gun power-driven turret in the tail of a bomber is well able to tackle a four-gun chaser."

The problem of countering the night bomber, which is engaging the best scientific brains of all belligerent countries, still defies solution. Britain is "very hopeful of finding the means to defeat the night bomber but the problem is still very far from being solved," according to Air Marshal Sir Philip Joubert. He said :—"In this war we are coping with an enemy flying up to three times as fast as he did in the last war and flying twice as high with all sorts of aids to help him to escape detection. Our fighter boys have a stiff problem before them. They have to have something more than cat's eyes to see the enemy."

The *Luftwaffe* attempted to invade England in daylight and by sheer force of numbers to beat down our defences. That effort cost them dear. They sent over individual bombers using the cloud as cover to attack vital objectives. Loss of many of these lone raiders made the change again. The third scheme was to send occasional strong forces to bomb our air fields and communications. One of these attacks lost 20 per cent. of its numbers. Then he tried escorting small numbers of bombers with powerful fighter forces to our vital points. In this fighting British losses became heavier, but took a greater toll of German Air Force and in particular its fighters.

Germans then adopted night bombing, " a form of attack hard to parry," in the words of Air Marshal Joubert.

Even the German air expert, General Milch, has admitted the difficulties of aerial defence, to the German public. Exhorting Germans not to expect miracles from German anti-aircraft defences, General Milch said, that there were technical limits for every night defence. Defence by the night fighter was the most difficult of all, it could only be solved after the air-craft had been located by search-lights.

An official *Communique* about air battles for London issued in September 1940 stated : Enemy bombers rarely get through in daytime ; most people carry on work during the day raids. But night raids are a different matter altogether. German bombers get through despite gun barrage and by nine o'clock the streets are deserted. Since shrapnel from guns can cause injuries, all travel is considerably restricted. As early as 6 o'clock people enter underground shelters equipped with blankets, food, books and many thousands sleep in underground railway stations. Shelters above the ground which were recently built all over London are unpopular, for people prefer to sleep well below ground level.

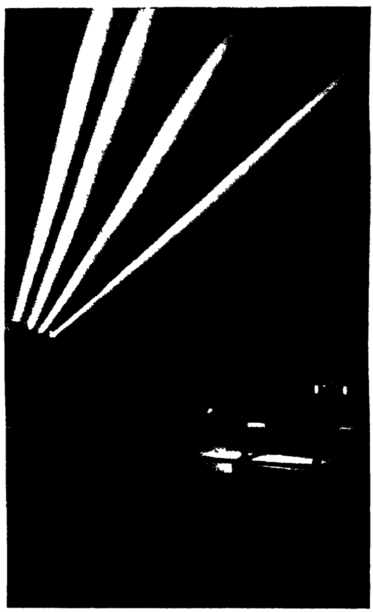
Anti-aircraft Guns

The answer to the night raider is slowly being evolved both by deterrents to accurate bombing and improvements in methods of location of the " unseen target ".

1. Certain " gun-zones " open up fiercely and others remain strangely silent, it may be assumed some trick is being played on

A typical Anti-Aircraft Gun

A.-A. Gun Shells



Search-lights in action

London children with destination label ready for evacuation

A Fire-fighting party in action

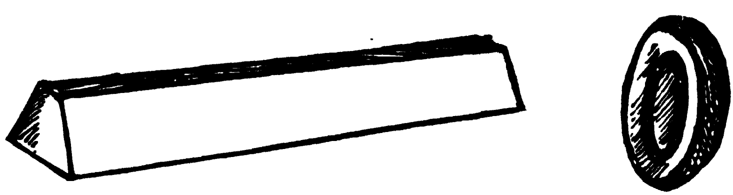
the enemy with the idea of misleading him as to his whereabouts. It may induce him to drop his incendiaries in wrong places.

2. Another method is concentration of fire. This battering of the estimated position of enemy raiders at any given moment is used far more frequently than the barrage of " wall of fire " which is only resorted to in extreme cases either in London or elsewhere. Some notable past successes can be quoted.

3. The best brains of the country have decided upon a scientific medium for making night raids eventually too expensive for Germany. This medium cannot be disclosed.

Some instruments are already in use. When perfected they will, it is hoped, provide data as to the position of an air-craft and will be used in conjunction with the defences. Engagement of a sub-stratosphere raider which the Germans may adopt when lower levels are made too hot, is not being overlooked. British anti-aircraft shells are capable of reaching a height of 38,000 feet.

The anti-aircraft gun can fire its shells to a height of over 30,000 feet. It is aided in its attempt by searchlights and sound locators and constitute a potential danger to bombers. Mounted in strategic positions or near important targets they are intended to keep bombers away. It is now part of the defence organisation in most European countries. The anti-aircraft army which was 6,000 strong three years ago, is to-day one hundred and twelve thousand strong in Great Britain. British anti-aircraft guns and searchlights are spread in a white chequer board over the land, by lonely copses, alongside farm buildings, in hills, and in fen country keeping increasing watch over the country day and night.



Anti-aircraft shell shrapnel picked up in Spain. The disc is about the size of a penny and the rod is 2¼ inches long.

The anti-aircraft shell fragments and explosion can shatter the aeroplane, and even a nearby bursting of the shell is dangerous,

but the fact is that even a nearby explosion is difficult to obtain.[1] For as the British Ministry of Munitions pointed during the last war. "Assuming an aeroplane to be travelling at 100 miles an hour at an altitude of 8,000 ft. it is obvious that during the time a projectile from an anti-aircraft gun took to reach this height the aeroplane could have altered its direction and movements in three dimensions over a very wide range. In order to secure a hit on it no less than 1,62,000 anti-aircraft guns would have to fire simultaneously."[2]

Recent experience supports this view. In the fourth R.A.F. night survey of Germany carried out in February, over heavily fortified areas in Western Germany, the bombers were caught in beams of multi-coloured searchlights and this activity was greatest ever encountered in the neighbourhood of Cologne and Dusseldorf. One section of the flight was under intense fire for some minutes and for another spell dodged spasmodic bursts. " Screaming onions " (incendiary shells which in some cases are linked by chains designed to wrap them crashing to the earth in flames) were discharged at the aircraft but they missed the mark. One battery of four guns fired greenish coloured tracer balls, and elsewhere red and orange fire balls were shot under the air-craft. These long distance bombers " ran the gauntlet of the whole German anti-aircraft defence with one exception."

These flights were carried out at a high altitude, but the British attack on Sylt at the end of March 1940 provides an instance of low-flying raid carried out over specific targets protected by anti-aircraft defences. Successive waves of bombers attacked during a bright moonlight night, the seaplane base at Hornum. For seven hours singly and in relays they maintained continuous assault on the seaplane base and obtained direct hits between the hangars and close to them. A vast quantity of bombs was dropped and reports indicate extensive damage done to hangars, workshops and slipways. All the British bombers returned safely with the exception of one. When two British bombers suddenly swooped from low-lying

[1] It is reported that a new type of anti-aircraft shell has been developed in the United States. " The shell is fired in the usual manner, but it releases a parachute trailing hundreds of feet of steel tape designed to foul the propellers of the raiding aircraft " (The " Hindu " Jan. 15, 1940). Another type is reported to be used in Germany. And are described as picturesque by the R.A.F. pilots against whom they were used. The efficacy of these shells is yet to be proved.

[2] Quoted ; Norman Angell.

clouds at terrific speed followed by other planes over Sylt the sirens began to wail and anti-aircraft guns and searchlights came into action. The barrage was heard over whole of the island, and the effect was that of a giant fire-works display. Yet the raid was successful and carried out by waves of bombers every half an hour from 8 p.m. onwards. One of them dropped several bombs on the Hindenburg dam resulting in huge flames.

The damage to Sylt include direct hits with high explosive on two hangars, on the railway connecting Hornum and List, on the land entrance to the jetty, on or near the seaplane slipway, and on the oil storage tanks.

" Forty-nine planes took part in the raid and each worked strictly to the time-table. Each plane bombed the base at the appointed time and from the appointed height in spite of the big barrage of fire from the German anti-aircraft guns, shore batteries and from which projected reddish missiles like the Roman candles. The planes returned back in the order in which they had left. They dropped altogether forty-two tons of bombs. Each plane carried about two tons of explosives including several other missiles and incendiary bombs."

A formation of British Bombers penetrated enemy defence in the Jade estuary in April 1940, and successfully reconnoitred the Wilhelmshaven naval base, where an enemy warship was attacked with bombs. Further south four enemy destroyers were also attacked. No damage or casualties were suffered by British air-craft all of which returned safely.

A German warship lying off Bergen was attacked and bombed next week by aircraft of the R.A.F. Bomber Command. One large cruiser was hit and other ships were probably damaged. The attack which was made by relays of air-craft in quick succession was delivered by a strong force of long range bombers in the face of intense anti-aircraft fire from the warships. A series of bombing attacks were made by aircraft in sections in line astern. " Despite the intense fire to which they were subjected all British aircraft returned safely making a night landing at their base after a flight of approximately eight hours' duration."

Russian air raids over Viipuri further prove that even if they were alert and active the target can be bombed successfully. Forty-

seven Russian planes raided Viipuri on the 3rd February, 1940, poured over 500 bombs into the town and obtained 150 direct hits, damaging all principal buildings. It was a daylight raid and the sirens wailed without break all day. " The machines flew too high to be in danger for anti-aircraft guns."

Especially for an attack with incendiary bombs which can be rained over a town, air-craft need not come low. Even those who pin their faith in active defence, in fighter air-craft and ground batteries to deal successfully with bombers, hesitate to assert their effectiveness. They feel that mass attacks on Britain had not yet been made to judge the efficacy of preventive measures and admit, " if the Germans were prepared to loose, say 1,000 out of 2,000 of their bombers, . . . they might inflict serious losses."

A new method developed to counter night bombing is the method called box barrage. It is in operation now over London at night. Having a determined height, course and speed of the incoming air-craft, 4 anti-aircraft guns working in conjunction "box in" the invader; unless the enemy pilots are very quick and dive and evade they are apt to be disabled if not directly hit.

The anti-aircraft defence of London against night flying raiders is now worked on two separate methods, the anti-aircraft guns firing with the aid of a new predictor system and night flying fighters co-operating with searchlights. Each system of defence is allotted a separate area of sky.

A new predictor for the guns is the essential part of the new system. It predicts with greater accuracy, " plotting of the position and height of the bomber " and sends the message to the a.a. gun position. " To reduce the margin of error and increase the chances of an aeroplane flying into a burst even though it should change course between the moment of prediction and the arrival of the shell, a method. of firing termed the " box barrage " is used. That means that four or more guns served by the predictor fire practically simultaneously, endeavouring to " box " the aeroplane between four shell-bursts, all or any of which may cripple it. Whichever way the machine turns it still finds itself within the box. Rapid changes of height is perhaps the best method of evasion. But when such action has to be taken one object is achieved—bomb aiming is impossible.

Prediction is a most delicate operation in which allowance must be made for atmospheric conditions, the fact that the target sometimes travels two miles between the instant a shell is fired and when it bursts, and the evasive tactics of the enemy flying on a curved course and changing course after the gun is fired.

The R.A.F. has shattered Field Marshal Goering's dream of inviolability of Germany's aerial frontiers by its leaflet raids as far as Prague and Vienna. The Norway chapter contained a stirring record of what a few determined young men can do under hazardous conditions against heavy odds. Then, in France and the Low Countries the R.A.F. made great holes in the armour of invincibility which appeared like a shield of the German Army from above.

It is estimated that British bombers have flown more than three million miles over a country, where, Marshal Goering boasted, no British aeroplane could penetrate. British pilots who flew so low that at times one felt the machines would strip the roofs off the houses.

British bombers attacking the centre of Berlin one night in March 1941, had to make their way through an intense box barrage. In spite of this attempt to protect the heart of the German capital, a large force of British bombers crossed and re-crossed Berlin. Some flew along Unter Den Linden—within a mile or so of which are five of the main railway stations—keeping on a steady course in order to take their aim.

According to the Air Ministry "compared with the successes of the British night fighters, the *Luftwaffe's* attempts to counter British night bombing have proved a signal failure."

An Air Ministry News Service states that Anti-Aircraft batteries had been bombed in the face of terrific fire and searchlights machine-gunned and put out of action in July 1940. Concrete runaways had been hit and wrecked, hangars set on fire and machines destroyed on the ground.

The R.A.F. has scored direct hits in several important places in Berlin. Bombs have been dropped in the Hermann Goering Strasse, only 10 feet away from the house of Dr. Goebbels.

.. The interruption of work during air raid alerts is more widespread and more serious in Germany than in Britain, according to an official survey based on the latest and most reliable reports reaching London.

Nazi pilots have sailed through the barrage of a. a. gun shells on south-east coast of England, with incredible recklessness.

The R.A.F.'s new Beau fighter air-craft which sprang into fame at the beginning of the " battle of the full moon " scored a further brilliant success in March 1941. Two pilots flew over an enemy aerodrome in France during one night. Bombers were on the ground, but the R.A.F. pilots braved a heavy anti-aircraft barrage to come down low, destroyed two searchlights, damaged anti-aircraft guns and set at least one enemy bomber on fire.

Many waves of British bombers penetrated a curtain of anti-aircraft fire over Kiel, but dense clouds of smoke soon hampered the searchlights and in the end the very weight and resolution of the attack bore down the defences of what had been one of the most heavily defended areas in Germany.

Enemy warships under construction in Bolhm and Voss ship-building yards of Hamburg were heavily attacked by R.A.F. bombers. Tons of high explosive and over one thousand fire-bombs were dropped on shipyard and docks in the immediate vicinity in a raid which began soon after dark. A heavy ground haze, great searchlight activity and intense anti-aircraft fire made conditions difficult for the raiding crew, but by making individual attacks from different directions and heights they were able to evade ground defences and press home their attacks.

The heavily defended naval base at Wilhelmshaven, has been attacked by relays of heavy bombers of the R.A.F. as also numerous anti-aircraft batteries in Germany and the German-occupied territory.

In high altitude level-flight bombing, air-craft are out of sight in the clear sky. Harold Francis McEnnes, European representative for the Bendix Aviation Corporation, told of a raid on the Citroen automobile plant outside Paris. " There were about 250 planes in the attack," said he. " They were so high you could not see

them but their number was estimated by the number of bombs dropped. Their accuracy was terrific. Of all the bombs dropped . . . the majority plunged right into the factory."

Level-flight bombers which fly at high altitudes are out of effective range of anti-aircraft batteries, and also force pursuit planes to climb higher and farther to give battle.

Thirty thousand feet and more was the common height at which raiders crossed the coast and made for London in the eventful days of 1940. *Reuter's* Air Correspondent pertinently pointed out that interception well over five miles up is difficult since manœuvrability of the defending fighter is very much reduced near its ceiling where the controls are apt to be sluggish. At that height, the enemy is well out of range of the anti-aircraft fire. The new Nazi tactics coupled with superiority in numbers account chiefly for the smal losses the *Luftwaffe* suffered lately.

By skilful evasive tactics and gliding attacks, the R. A. F. night raiders are slowly getting the measure of the ground defences with the result that casualties have been remarkably few. In daylight raids, they have attacked the aerodromes at Schipol and Haamstede.

Shooting down a bomber does not seem to eliminate the danger of air raids. When the bomber is shot down, its load of bombs may explode and cause severe damage to surroundings. A huge crater was caused when a bomber with a load of bombs fell in S. W. London and exploded.

Mr. Churchill as First Lord of the Admiralty in his speech in the House of Commons in April[1] revealed that 60 German air-craft successfully attacked Scapa Flow on 10-4-1940. "In all there have been five raids on Scapa Flow—in the first a cruiser was hit which necessitated several weeks' repairs . . ." According to Churchill's testimony Scapa Flow could deliver the "heaviest concentration of anti-aircraft fire in the world," but in the April raid in which 60 air-craft took part and raided in waves they suffered a loss of "6 air-craft" not very much when compared to the defensive fire.

In the Norwegian campaign Nazi planes succeeded in bombing British battleships and cruisers. Two cruisers were damaged

[1] *Vide* "Hindu" 11-4-1940.

by splinters. One very heavy bomb hit the flagship *Rodney* but her very strong deck armour resisted the impact and she was unaffected in any way by the explosion except that three officers and seven men were injured. The cruiser *Aurora* subjected to five successive bombing attacks pressed home with courage, escaped, but the destroyer *Gurkha* accompanying her was hard hit and sunk.

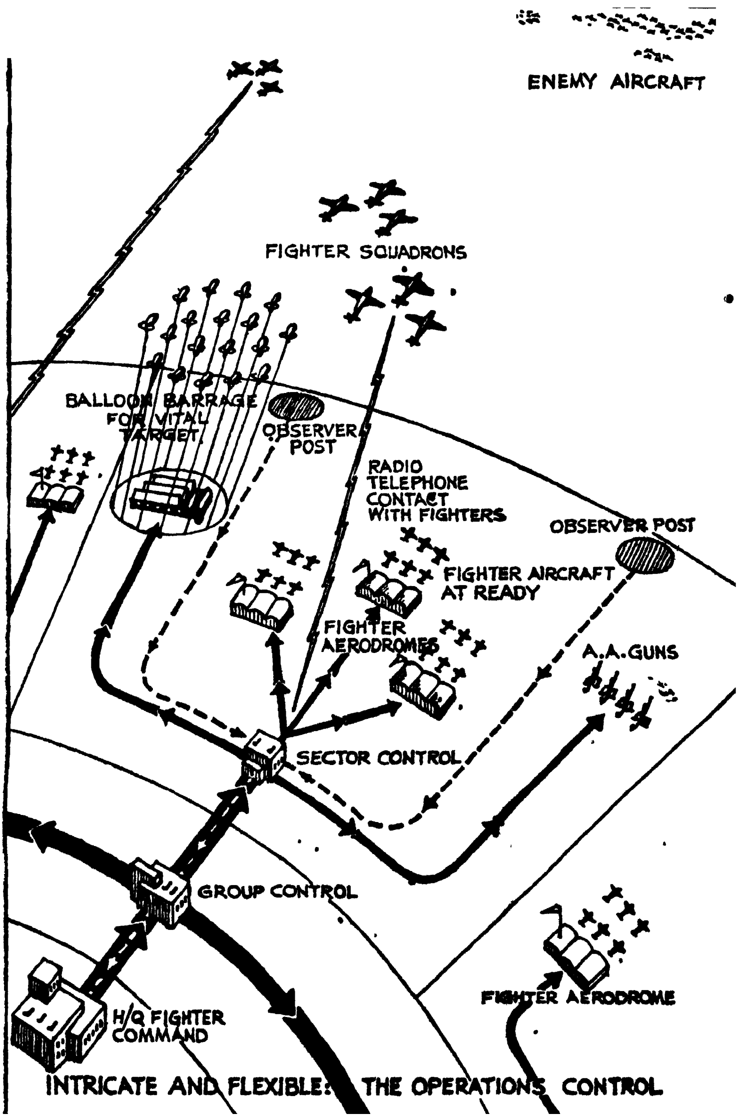
A highly successful daylight raid was carried out by the R.A.F. over Rotterdam a well protected area, in July 1941 resulting in damage to twenty-two ships. • Direct hits were made on many ships including one vessel of over 15,000 tons. A ten thousand ton ship was hit in the middle. In all seventeen ships of an estimated tonnage between 90,000 and 100,000 tons have been put out of action either permanently or for a long time to come. Five more ships totalling between 40,000 and 45,000 tons were severely damaged.

The R.A.F. has succeeded in straddling with sticks of the latest type of heavy bombs the German battle-cruisers *Scharahorst* and *Gneisenau* at Brest. British pilots in a suicide dive, dropped to 1000 feet before releasing their loads, in a region so well protected by anti-aircraft devices.

A huge fire broke out in one of the cruisers and could be seen 80 miles out at sea.

Japanese bombers and fighters, considered out of date and of "a low quality", have been able to sink one of Britain's latest and mightiest battleships. Japanese bombers, considered to develop a speed of under 300 miles per hour maximum, escorted by the fighters caused terrible destruction to Pacific harbours and American battleships.

A new tactics already come into vogue threatens to undermine seriously the efficacy of anti-aircraft batteries. Raiders come without making noise and no warning is possible of impending attack, as reports of Russian raids over Finland indicate. Twenty were killed and fifty wounded in a series of air raids over Abo during the close of January 1940. Dozens of houses were destroyed. "Fifty Soviet bombers silently swept down on the city with engines cut out. The raids were the worst Abo hitherto suffered."



Organisation and plan of operations to intercept enemy bombers, by fighters and anti-aircraft guns

Gliding long distances is possible and it is estimated that by reaching high altitudes and gliding after closing the machine a distance of even 100 miles could be covered. Sirens and sound detectors could be deceived and anti-aircraft batteries would never come into action.

It is also considered possible to aim bombs upon targets protected by anti-aircraft guns without bringing the bombers into their range.[1] The rocket glider type of bomb is mentioned as the weapon which would neutralise the value of anti-aircraft guns and ground defence.

Balloon Barrage

Bombers flying low and fast render the task of anti-aircraft batteries difficult, for the heavy guns cannot be quickly adjusted to take successful aims at rapidly moving objects: To prevent low-flying attack which is particularly destructive, the Balloon Barrage is improvised. The idea behind the barrage is simple. They are light balloons floating all round the city or other important objectives and anchored to earth by fine but very strong steel cables. These make a veritable tangle of wires all round the target to a height of some thousands of feet. It is considered almost impossible for aeroplanes to dodge in and out among them particularly at night. Bombers attempting to get through would hit one of these wires and although it may be broken, its propellers or wing or tail would get torn off and mark the end of the bomber.[2]

The main purpose of the balloon barrage seems to be to keep the bombers high up, and to prevent them from coming low and effectively bombing the targets. Higher up, the bursting shell of the anti-aircraft guns and fighter planes would deter the bomber. These three are complementary and are intended to keep the bomber very high from where it could bomb only at random.

Their purpose is to prevent dive-bombing and low-flying attacks and to drive enemy planes up so high that they come within range of anti-aircraft guns and can better be dealt with by fighter

[1] "Ajax," Air Strategy for Britain.

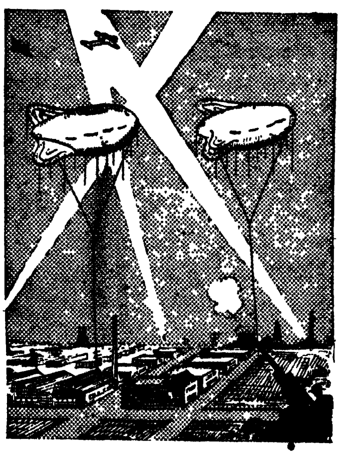
[2] L. Matters, "The Balloon Barrage." The "Hindu," 24-9-1939. For the Balloon Barrage exercises and the Opposition view on the matter. *Vide* the issues of the 26-7-1939 and 29-7-1939.

planes. The steel cables to which the balloons are attached are strong enough to cut through a colliding plane.

Vessels sailing in convoy are now equipped with barrage balloons against the dive-bomber. The technique of the bomber pilot is to swoop at great speed almost vertically over his intended victim, to flatten out at the very last moment, and then discharge his bombs from a very low altitude. The balloons are an effective answer to these low-level attacks, for dive-bombing under these conditions becomes an extremely risky business. The balloons are flown by patrol vessels, which are all manned by R.A.F. personnel.

It serves London and other British cities as part of the defence against air raids. There may be 500 to 1,000 balloons around the city of London, and the system has been extended to ports and harbours and other important areas in England and Scotland. Bombing planes will always endeavour, if they can, to unload their deadly cargoes on specific targets, and these would naturally be what are called the vulnerable spots. The chance of success in such aiming is obviously greatest when the bomber can get close ; if he cannot fly low, his aim must be erratic. He can drop his bombs from any height and get some destructive result somewhere, but while he flies high he has to take " pot luck ". More than that he is in his greatest danger when he flies high and cannot swoop, dive and dodge.

If the Air Staff thinks highly of the efficacy of the balloon barrage, there are others who hold that the balloon barrage is an over-rated protection—who point out that cutting edge planes are being experimented in Germany. Recent events have confirmed their belief. Royal Air Force bombers successfully dodged through the wires and bombed railway lines in Germany. And Nazi pilots have shot down the balloons in flame and attacked the targets.



The Balloon Barrage

The Germans have a device similar to the balloon barrage. These are known as *Flaming Onions.* These are a number of parachute shells linked together by wire and when fired into the air drop slowly and provide a spectacle as though a number of onions are stringed together. Yet another device reported are shells which release miles of coiled wire in mid air. A barrage of these wire fences in the sky would indeed be a very effective defence against raiders.

German fighters over Dover have also shot down barrage balloons. Thick fog and low cloud above which the balloons floated, obscured the raiders from the anti-aircraft defences, but they were given a hot reception. Some balloons were shot down.

During the afternoon of 29-8-1940 a lone Messer-Schmidt over a South East area played a daring game of ninepins with the town's barrage of balloons. It cruised so casually over the town that it went unchallenged and then swooped on a balloon and shot it down in flames and zoomed away returning a few minutes later, shooting down two balloons close together. Then sailing recklessly through a furious barrage the raider dived so low that the Swastika on the wings was visible in the streets and attacked and felled another balloon before hurtling out apparently unscathed.

In the closing days of August 1940, during a savage attack over a South East Coast town by Nazi " Yellow Nose " squadron, the ace pilots of Germany shot down some of the balloon barrages. A savage attack was launched in the glare of early morning sunshine. Some balloons fell in flames as twelve of the "Yellow Nose" squadron swooped on them from different directions, their machine-guns spitting incendiary bombs. Anti-aircraft guns of every calibre thundered into action, filling the sky with bursting shells and "flaming onions". The raiders pressed home the attack with suicidal recklessness. Shrapnel and spent incendiary bullets littered the streets of the town like hail. Finally the raiders made off towards the French coast.

Reports from the German frontier state that a new type of Junkers planes made of transparent material and stated to be scarcely visible at a height of 2,400 feet is being constructed at big air-craft factories at Wiener and Neustadt in Austria, according to

reports reaching the German frontier. The machines are reported to have engines of 1,100 horse-power and a speed of 390 miles per hour.

Neither side is yet in sight of a solution of the night raider problem although Britain is showing that she is just a step ahead of Germany. Both appear to be relying chiefly on night fighters who now operate over enemy's bases over the sea, over the approaches to targets and over the targets themselves—in fact, endeavouring to switch to gradually as big a force of fighters as are available.

The warning that the night bomber menace had not yet been mastered and every town must prepare for the worst has been uttered by Mr. Herbert Morrison, the Home Secretary, " I do not know whether we shall be triumphant over the night bomber."

To quote Mr. Churchill, "Every method of dealing with air-fighting by night is being studied with passioned zeal by a large number of extremely able and brilliant scientists and officers but hitherto we have not been more successful in stopping the German night raiders than the Germans have been successful in stopping our raiders, which have ranged freely over Germany and struck very heavy blows. Although we have noticed a considerable improvement from our search for remedies, we must expect a continuance of these attacks."[1]

All authorities, therefore, agree that so long as other nations possess aeroplanes, no defensive force whatever can prevent some getting through the defence, and doing an amount of damage which might settle the issue of the next war by simply putting the nation at the beginning *hors de combat.*[2]

[1] **Dr. Lee de Forest, an American Scientist, suggests bombing by television. A small plane, loaded with bombs, but with no humans aboard, is manœuvred by remote control from another plane 10 miles or more behind. A television camera is also carried by the ' bomber,' enabling it to be steered accurately by the pilot in the controlling plane, who sees on the screen all the objects ahead of the pilotless plane. Thus, from a comparatively safe distance in the rear, the man in the control machine can guide the ' bomber ' direct on to a military objective. Crashing on the target, the little plane and its television apparatus are completely destroyed in the explosion; but as all materials are the cheapest possible, the loss is relatively small.**

[2] **Norman Angell, p. 59.**

Evacuation

To reduce the quantity of destruction and minimise the expenses and difficulties of protecting large number of people, their buildings and structures, evacuation, camouflage and obscuration of light are adopted. Every country threatened by the air arm has resorted to these measures. In fact a plan for evacuation was prepared even in 1931, in France. It was the first step Marshal Petain took when he was appointed Inspector-General of Aerial Defence. Warsaw, London, Berlin, Oslo, Helsinki, etc. recently adopted it. Evacuation if very successful, can reduce the expenses and trouble of making adequate provision to deal with casualties, but experience, however, shows that effective evacuation is not possible and that voluntary evacuation almost fails to disperse the population.

The aim of evacuation is to remove from the more dangerous and congested areas to less dangerous areas of certain groups of people whose removal is desirable on both national and humanitarian grounds. The most elaborate and perfectly planned scheme in England has disclosed several disadvantages—set-back to education for the younger generation, trouble to householders in receiving strangers, difficulty of food supply, articles of consumption and medical aid, break up of family life with all its serious handicaps, and above all, the risk of the homes of the evacuees being burnt down by incendiary bombs. The battle of the flames needs millions of people to keep watch and if large numbers evacuate the task of dealing with incendiary bombs would be extremely difficult. If a large proportion of people has to remain, the task of protecting them is in no way reduced. This is the dilemma which evacuation gives birth to.

A most elaborate organisation has been set up in Great Britain. From London and other vulnerable centres over a million and a half children, mothers, and hospital patients were removed to less vulnerable zones in Great Britain, during the first week-end of September. In the shadow of the breaking storm, the great movement took place. The first surprise came early. The numbers coming forward to be evacuated under the official scheme were unexpectedly low. Less than half of those for whom billets had been promised went away.

Before the end of the first fortnight of evacuation it was evident that a considerable drift home from the reception areas was in progress. The expected air raids had not taken place. The drift back was most noticeable in the case of mothers with young children.

Whatever might be the cause of failure, the English experiment has made it clear that evacuation is difficult however thorough may be the scheme and however much willing the people and Government may be. There is, however, not much to choose between failure or success because the latter leads to grave consequences to the individual, the family and the nation, the inconvenience to householders, the difficulty to the evacuees, the break up of family life, and the loss of education.

Husbands have been parted from wives, children from parents. Domestic privacy has been invaded. Urban and rural ways of life have been brought into sharp conflict. Class barriers have been not so much broken down, as ignored, often with heartening, but sometimes with unfortunate, results. The education system has been reduced temporarily to a shamble and a great strain has been placed upon local Government authorities in areas which have received a great influx of population.

From the point of view of air defence, the task is not apparently lightened, unless a very large section evacuate. But this would prove dangerous to city structures, particularly if large scale incendiary bomb attack is made. Immediate attention which is necessary to deal with them needs a large army of fire fighters and fire watchers.

Camouflage

Buildings and structures cannot be evacuated, but they might secure some immunity if they escape the notice of the bomber. Camouflage measures are adopted to important objectives and installations whose destruction would paralyse resistance. Details of camouflage are dealt with later, but it would suffice to point out that the most perfect scheme cannot guarantee security to objectives in crowded cities where indiscriminate bombing will be resorted to. It is impossible to camouflage the entire city. The design, construction and location of many of the important objectives are such as to render disguise measures very ineffective.

Other difficulties too present themselves. Modern factories are so large that they could be considered to have no surroundings. Factories are so big that it would be a waste of paint to do anything to them. The idea of enveloping them in smoke is impracticable, for wind will blow it away.

By suitable painting it might be possible to make quite a large building look like a meadow from one aspect and in one light, but the illusion would disappear when the building was seen from another aspect or in another light, although the meadow may look the same in both cases. The reason is that while the structure is three dimensional, the ground is more nearly two dimensional. The Home Office of Great Britain, therefore, recognise this difficulty. They point out :—

Imitation of purely rural surroundings is difficult because the variations of light and shade on the roof slopes of the building itself are greater than those of the ground ; the tones of the ground remain more or less constant except for the shadow cast by the building, while the tones of the building are continually changing.

Another difficulty is the selection of material suitable for merging the target in the neighbourhood. Paints should be durable and at the same time should have a mat finish to avoid tendency to shine, two characteristics that are considered almost incompatible.

Disruption focusses the attention of the observer to something to the exclusion of all else. Structural disruption is, however, very expensive, although sound in principle. " The fixing of such excrescences so as to withstand the weather is not a simple matter" observes the Home Office which is fully aware of the need for camouflage. It adds further " It is not practicable to distort the buildings by shaped excrescences since they have to be so big." Camouflaging the roads is also very difficult. There is no known method of colouring existing concrete roads permanently. Bituminous emulsions most suitable for camouflage measures would absorb mustard gas and complicate the situation. R.A.F. activities over Germany where the most elaborate schemes of camouflage are in vogue have amply proved the inadequacy of such treatment to protect the targets in crowded and vulnerable areas. Crowded cities cannot be camouflaged wholesale.

Obscuration of Light

If camouflage is intended to prevent enemy detection during day, black-out is designed to escape airmen's attention at night. Night raids are particularly disastrous and lights are useful pointers to night bombers. Obscuration of light aims to secure " that as far as is practicable, hostile aircraft passing over the country at night would see no light which might serve to guide them to a particular objective or to assist them to determine their position." The restriction accordingly imposes general darkening as a permanent condition from the outbreak of hostilities.

The value of black-out cannot be belittled and its benefits cannot be ignored. But we should realise that four factors neutralise its effectiveness. Modern pilots are trained for blind flying, and reach their objectives with the aid of mechanical devices. Night raid was common even in the last war, and it has been improved since then. Large urban areas are, therefore, easily raided at night.

Secondly, in modern raids incendiaries are showered and conflagrations set up to detect objectives over which high explosives are aimed. If this illumination is insufficient or impossible, flares are dropped and the ground below lighted. So bright is the light shed by flares which are dropped singly or in chandelier type that Londoners one night were able to read the newspapers with their help. Nazi raiders dropped numerous flares and at one time about fifty were floating over Plymouth when it was blasted in April 1941. In the same month the West End, the centre of London's Theatre Land and night life, was bombed, blasted and burned by 'early raiders dropping chandelier-type flares, and in their wake, searching for the prey, came more and more droning bombers.'

Fourthly, the efficacy of a black-out is greatly reduced on bright moonlit nights. Several raids have been carried out by the R.A.F. and the Nazis with the help of moonlight. When the R.A.F. raided Hamburg in May 1941 a clear sky and a full moon showed up the ground in detail. The R.A.F. swept through the barrage and carried out a formidable bombing with marked success against the enemy fighters and ground defences.

The German Air Force took advantage of the moon to deliver their night attacks in October 1941. Five attacks were attempted

in one night and over 450 aircraft took part in the raids. On May 10, 1941 when the moon was full raiders were over London and attacked on a big scale. They swooped low to hit the objectives 'almost as low as the roof tops.'

Therefore, although illuminated objectives offer easy targets to the night raider the absence of illumination is no guarantee of safety. On the other hand, black-out produces serious disadvantages and dangers such as traffic accidents, anxiety to road users, depression and gloom to citizens, danger to health, risk of law-breakers and more than all hindrance to the quick and efficient functioning of A.R.P. services. Instances are already reported of how fires could not be immediately and effectively dealt with owing to the difficulties of darkness.

The value of measures for prevention and escape cannot, however, be denied. The battle of Britain could not have been won but for these measures. English cities would have succumbed and been destroyed as were Ramsgate and Coventry. The amount of destruction which the bombs that succeeded in penetrating the defences of London created for the Empire Capital is sufficient to prove the necessity for organising measures to deal with the consequences of raids. Baldwin's dictum, " the bomber will get through " has not been proved entirely true, but the incidents that support his prophecy are enough to tell us that every possible measure should be adopted to resist the weapons used in air raids and protect the people and their property from their effects if cities and civilization should survive the air menace.

CHAPTER III

PROTECTION TO PEOPLE

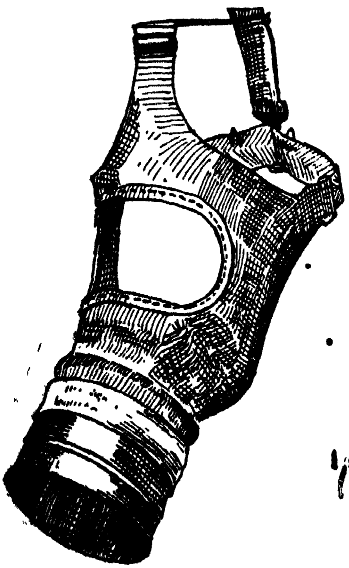
Chapter III

PROTECTION TO PEOPLE

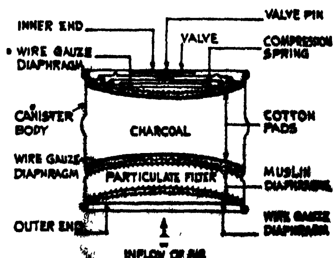
It is evident from the previous Chapter, that if inhabitants of vulnerable areas should survive a carefully engineered air attack, measures should be devised to protect them from poison gas vapour and liquid; fire and its consequences to city structures; shock, splinters, blast, as well as the demolition of buildings and falling masonry caused by the high explosive bomb. In addition they should be saved from the falling fragments of anti-aircraft shells. In an intense air-raid most of these would happen simultaneously.

Gas Protection

Protection against gas has been considered essential and respirators have been distributed free by the State to all the



Civilian Respirator



Civilian Respirator Container

people in the vulnerable zones of Great Britain. This, however, does not mean that the "mask" will protect them against gas attack. This is clear from its function and form. A respirator consists of a rubber facepiece with a transparent window, and a container which holds the gas filters. If properly put on, it protects the eyes, nose, mouth and lungs, and

a supply of pure air for breathing, by means of filters which are able to absorb any gas known to be capable of being used in war.

It offers no protection against ordinary domestic coal gas or carbon monoxide. It does not protect other parts of the body from poison gas vapour and liquid. It can be effective for about four hours only in contaminated atmosphere. At best it can be regarded only as second line of defence.

Anti-gas clothing no doubt covers the whole body, since it consists of a jacket, trousers, hood, gloves and boots. But mustard gas liquid can penetrate the best materials of which anti-gas suitings are made. In hot weather it can offer immunity for four hours when new, and for three hours when used and decontaminated by boiling. It is also inconvenient to resort to that protection, for the non-porous nature of this oilskin material causes the heat and perspiration from the body to be retained inside the clothing. In hot weather the amount of manual work that a person wearing oilskins can accomplish is consequently limited owing to fatigue and exhaustion.

Owing to the exhaustion caused by the heavy anti-gas suits they should not be worn unless the circumstances make it essential. Where adequate ventilation can be arranged to avoid dangerous concentrations of vapour, so that the only danger is from touching contaminated objects, the lesser forms of protection may be adequate and will cause much less reduction in efficiency. If work has to be carried on in a confined space with heavy vapour contamination present, necessitating the wearing of the complete outfit with hood, it is probable that only three spells of from half an hour to an hour could be performed during each 24 hours. This depends on the temperature. In cold weather, or in less severe concentrations which do not necessitate the wearing of the hood, men might be able to work for three spells of two hours. The protection against blister gas vapour afforded by the heavy anti-gas suit is of limited duration, owing to the suction effect produced by movement. The inside of such suits should therefore be ventilated at regular intervals by opening the coat and letting down the trousers in an atmosphere free from blister gas vapour.

Satisfactory protection is possible only by getting into gas-proof rooms and refuges, large enough to keep the inhabitants comfortable

Service Respirator and Civilian Gas Masks

Anti-Gas Suit

People taking shelter at night in an underground tube station in London

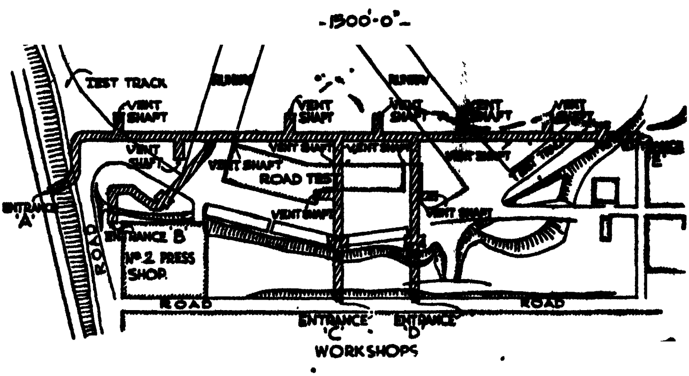
Inside a typical shelter in Chungking, when the Japanese raided the city

or long hours. This is now realised and gas-proof shelters are built wherever practicable gas-proof accommodation is improvised in home. In essence "gas-proofing" a chamber entails the sealing up of all the openings and crevices, and making it air-tight, and providing its entrance with suitable devices to facilitate entry and exit. Usually this consists of a gas curtain of heavy material carefully attached to the door, the frame being lined with felt or similar material.

That gas-proofing rooms in a tiled house is impracticable will be readily realised, but even in terraced houses ill-fitting doors and windows would create difficulties. The problem is further complicated by the intense heat of the tropics. Granting these difficulties are overcome, safety is not assured, since the incendiary and high explosive bombs can destroy them together with the inmates. For no normal residence and building can stand the high explosive, and, most cannot resist the incendiary. If the people who reside in vulnerable areas are to be assured protection of life and limb it is essential that they must be provided with accommodation, proof to gas, incendiary and high explosive bomb. This has been realised and bomb-proof shelters have been built both by governments and by factory owners.

Bomb Resisting Accommodation

Such accommodation has been improvised in the underground tunnels of Barcelona for one and a half million people, by the Spanish Government. The Austin Motor Factory in England has a bomb-proof shelter deep underground for its 10,000 employees.



Austin's Tunnel Shelter for 10,000 people

Undoubtedly the most effective protection is provided by a tunnel shelter many feet below ground, but the opportunity of providing this type of shelter is not frequent, owing to the presence of sub-soil water in some cases and to cost in others. Several comprehensive schemes of tunnel shelters have, however, been carried out and they must be considered as approaching the ideal form of air-raid shelter.

Built at a cost of £25,000 it is no less than a huge subterranean tunnel system excavated out of sandstone rock and conforms to a standard semi-circular design with a floor width of 16 ft. 9 in. and a height of 9 ft. being reinforced with steel arches and steel sheeting. Their average depth will be 55 ft. below the surface and with access through the gently inclined adits, it will be possible for full occupation to be effected in a few minutes after receiving an air raid warning. The tunnels would have a length of 1,000 yds. providing sitting accommodation for half the number of occupants. The air inlets situated 18 ft. above a very high ground which it is anticipated will be clear of any surface concentrations of gas, will provide efficient ventilation, and the entrance and exit adits are provided with air locks. Drinking water supplies, rest and first-aid rooms, lavatories and all essential amenities are included in this scheme which also will combine auxiliary generating sets in case of failure of mains, and loud-speaker equipment throughout the system for broadcasting instructions, music and news items to those taking shelter. It has been estimated that this involved the excavation and removal of 18,000 tons of sandstone.[1]

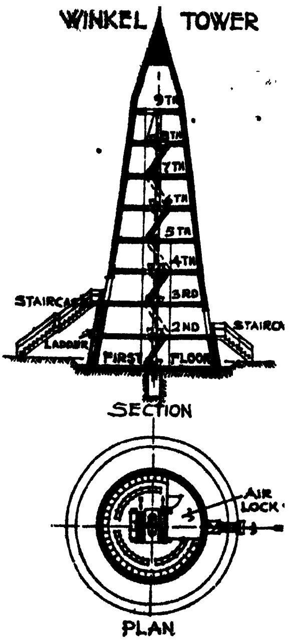
Conical and parabolic shelters above ground have been built to a limited extent on the Continent which are intended to avoid impact by offering the least possible surface normal to the surface of the shelter. Their unit cost is high.

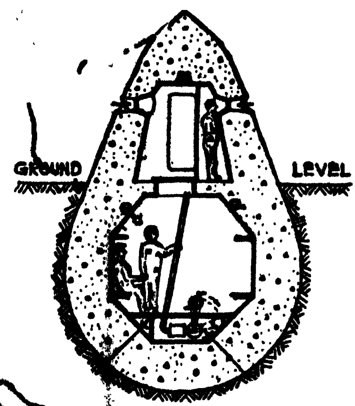
Bomb-proof surface shelters have been erected in Valencia. Such shelters accommodate from 250 to 1,250 persons, and are provided with sandwich roofs either domed or flat. The flat roof has steel and concrete protection in addition to a 2-in. concrete slab, two 3-in. layers of sand and a 5-ft. slab of concrete. The shelters are mechanically ventilated with electric power and have emergency dynamo equipment.

[1] The "Builder".

The Winkel Tower named after its German designer is also above the surface and conical in shape. This is intended to deflect bombs and prevent penetration. For that reason the outer walls have only to resist the effects of detonation, but have to be of constant thickness for the full height of the tower. It is also claimed that even heavy bombs exploding near or under the foot of the tower cannot imperil the stability of the structure. The Winkel Tower has been standardised . . . in four sizes, with a capacity, 400 people for the largest and 168 for the smallest.'

The Maginot Line contains large underground chambers absolutely proof to all known weapons of air attack. The pressure inside is kept higher and excludes the possibility of poison gases entering in. Equipped with kitchen, store, sanitary conveniences and efficient lighting,





SCHINDLER STRONGHOLD

telephone, etc., they are spacious enough even for parade. The towers of the Maginot Line weigh some 120 tons, are monolithic and no shell can penetrate the concrete wall. On the other frontier are equally formidable structures comprising about 12,000 steel and concrete forts extending from Holland to Switzerland. Some of them are built deeply into the hill side and some are in open territory, massive concrete towers with conical roof intended to deflect the bombs.

The Maginot Line is 325 feet deep and cost France over one hundred million pounds to build. The Siegfried Line cost Germany seven hundred and fifty million pounds, according to Mr. Neville Henderson.

In Gibraltar, underground fortresses have been cut out of living rock. They are large enough for defence exercises and to provide food and shelter to the army. Bunks have been fitted for men's quarters and there are wash and cook houses all of which are capable of providing food for 5,000 people.

Though uncompleted, the Rock now contains three-storied barracks capable of housing thousands of men. There is a fully equipped hospital, an electric power generating system, well fitted wash rooms and cook-houses. Vast quantities of oil, water, food, tobacco and even boiled sweets have been stored in subterranean tanks.

Instances of direct hits on air raid shelters by bombs come from Finland. It is reported only a miracle saved the inmates from the Russian bomb. A bomb stuck the air raid shelter in which Swedish Foreign Minister M. Sandler took cover during his recent visit to Finland, with a number of other people and shortly after the raid began a bomb hit the shelter causing the pillars to collapse. He played a leading part in exhorting the people to keep calm.[1] Eleven war planes flew over Abo on January 20, 1940 and dropped bombs from 16,000 feet. Several bombs fell on a maternity home some penetrating the air raid shelters. Mothers carrying the new-born babies, escaped miraculously by climbing a covered staircase.[2]

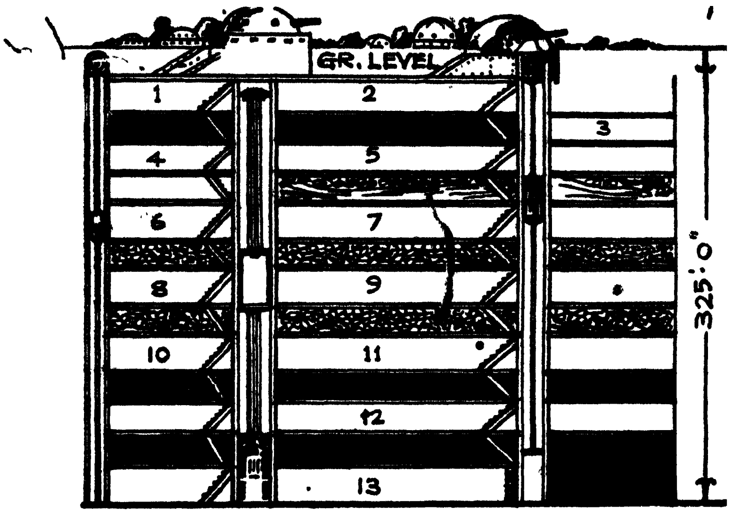
Several instances of direct hits to air raid shelters have now been reported from all parts of the world:

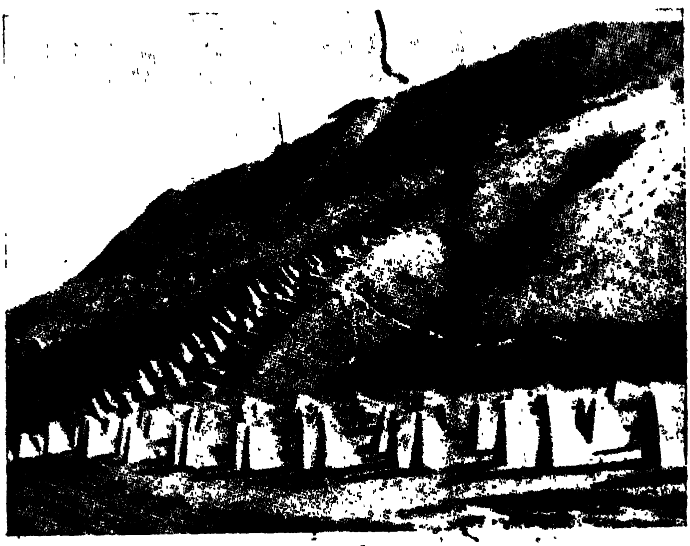
In the first biggest raid of London in September 1940, over five hundred enemy air-craft took part. Ninety-nine were brought down, of which 21 by anti-aircraft fire. The bombing was wide spread and indiscriminate. Some services were seriously interfered with. Civil defences services did marvellous work.

Four hundred people were killed and 1,300 to 1,400 were seriously injured. Children sleeping in perambulators and mothers

[1] The "Hindu", 23-1-1940.

[2] The "Hindu", 22-1-1940.





German fortified Siegfried Line

with babies in their arms were killed when a bomb exploded in a crowded shelter in the East London area in last raids.

A Press reporter who visited the shelter afterwards writes; 'the bomb fell directly on a ventilator shaft measuring only about three by one foot. This was the only vulnerable place in the powerfully protected underground shelter, accommodating over a 1,000 people. The bomb fell just as families from scores of nearby streets were settling down in the shelter to sleep there for the night. Three or four roof support pillars were torn down and about fifty people lay stunned in heaps.'

It is believed that 14 persons including children, were killed and about 40 injured one night when a bomb fell on a shelter in one East End area crowded with over a thousand people, although bombs were still falling nearby.

A London sub-way leading to an underground railway station was hit during a Saturday night's raid. Nothing recognisable remained of the sub-way in which numbers were sheltering when a heavy bomb fell. A huge crater was created. The crater was so large that one hundred royal engineers, pioneers and other demolition squads working therein appeared to on-lookers like pigmies. Four huge cranes were placed round the edge to swing tons of debris into lorries.

The worst effect was on an underground shelter which was covered with debris when a neighbouring building was struck, cutting off a number of people. Not one property escaped damage in an area extending over a quarter of a mile in radius in one Central London area.

Communal shelters were bombed during widespread night attacks on London and Provincial areas in October 1940. Fatal casualties occurred in them in a north-east town.

An underground station was struck by a bomb and damage was caused during a night's raid on London.

A number of persons sheltering in a public house in a town in East Scotland were killed when it was demolished during a raid.

Most of the fatal casualties in Bristol area were caused when a public shelter received a direct hit.

A public air raid shelter received a direct hit in London in September 1940. It was a covered trench in a public square. Fortunately one casualty resulted from 70 people who were sheltering. The roof covering was blown off over a few feet.

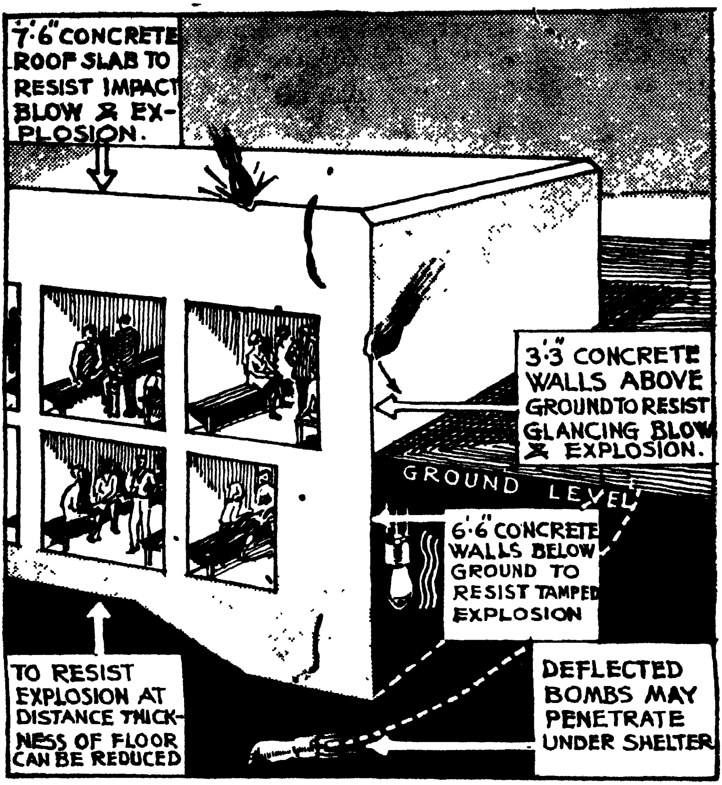
A Belfast air raid shelter received a direct hit in April 1941, killing a number of people.

While one shelter provided for members in the House of Commons had resisted explosion when the Mother of Parliaments was bombed in May, another shelter provided for the use of the Prime Minister and other members of the Cabinet was badly wrecked.

A surface shelter was hit in Portsmouth and several people were killed or injured in April 1941.

Over a thousand people marched in order from a shelter 60 feet underground to near-by surface shelters when the roof of a famous London building above them was set ablaze by a bomb one night. Despite its depth, the vault was shaken by the force of the explosion. In a North London area a bomb fell on one of London's most famous streets causing a great crater and blowing out windows for a considerable distance.

Massive structures designed with great care are essential, because, experience and research have disclosed that structures less massive and strong cannot resist the impact, penetration, explosion, blast, earthquake effect and splinters of the deadly high explosive bombs now used in aerial attack. The medium size high explosive bomb can penetrate 5 feet of reinforced concrete, can attack the side as well as the floor of a structure by glancing blow and tamped explosion respectively. Protection worth the name should resist all these and technical experts and leading institutions therefore strongly plead for erecting bomb-proof structures for protection. Even the Government of Great Britain which pins its faith in blast and splinter-proof shelters for every home has been forced to focus its attention upon this question. From the suggestions made by the expert committee appointed by the Home Office Air Raid Precautions department to "prepare design methods and type designs for protection of varying degrees against the high explosive bomb," it is clear that to assure protection to people from

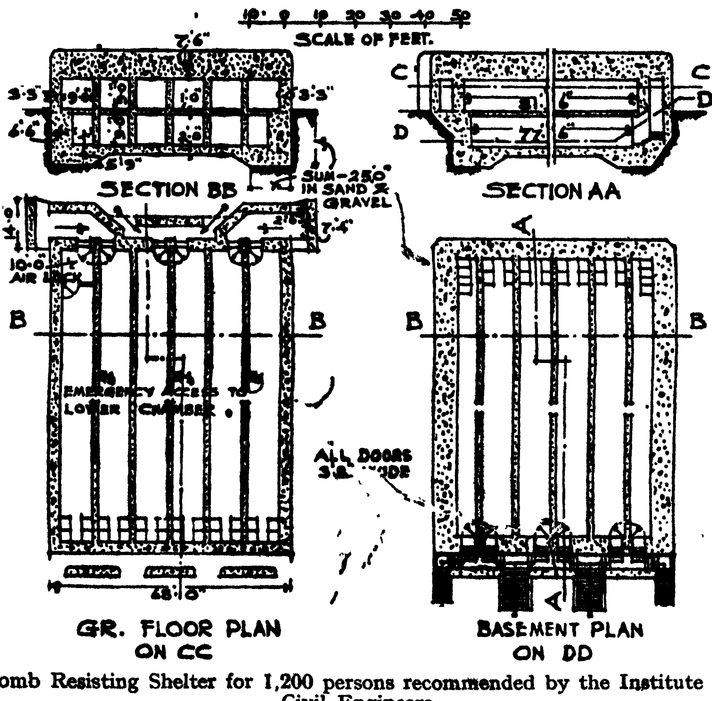


Detailed perspective view of the shelter recommended to afford protection against direct or rear hits by heavy bombs, by the Design Panel set up at the request of the Home Office by the Institute of Civil Engineers [1]

[1]Mere blast and splinter-proof shelters 'give no more of that kind of assurance and sense of security that are the real basis of civilian morale when the bombing is heavy and eccentric. The former official opposition to deep underground shelters is now seen to have been stupid, if not wanton, and although the authorities have constructed an enormous number of fairly reliable brick street surface shelters to supplement the individual house 'Anderson Shelter,' there still exists no confidence in those areas of crowded population where the people have seen half a block of ramshackle dwellings blasted into rubble by one bomb." Practically every newspaper is now demanding the provision of shelters that can offer complete protection. Because it is known that they cannot be built quickly, the public are now resorting to the subterranean railway tubes and stations as refuges, although official opinion did not relish the idea. (The London Correspondent, The "Hindu", November 21, 1940).

the effects of a 500-lb. high explosive bomb the shelter must be built with roofs, walls, and floors of the thickness indicated in the opposite illustration.

These designs are based upon the shelters being divided into compartments with not more than 200 persons in each compartment. The shelters designed consist essentially of two-storey structures of a box form, either rectangular or circular formed of reinforced concrete and placed generally half above and half below ground, easy access to the basement storey being obtained by means of staircases. Shelters placed at a considerable depth below ground were not considered in any detail, although it was realised that there should not be any great difficulty in designing them to provide degrees of protection similar to those afforded by the recommended designs.



Bomb Resisting Shelter for 1,200 persons recommended by the Institute of Civil Engineers

To meet the combined effects of direct impact, disruptive force of explosion and spalling effect on the inner surface, of a 500-lb.

heavy case bomb striking at its maximum velocity, the thickness of the concrete recommended is 7 ft. 6 in. for the roof (5 feet only for medium case bombs of 500 lb. and for heavier bombs with lighter case)[1] 3 ft. 3 in. for walls above ground, and 6 ft. 6 in. below ground; 6 ft. 6 in. for the base except in large shelters, where under certain conditions the thickness could be progressively reduced to 2 ft. 6 in.[2]

This overhead cover of concrete of special quality adequately reinforced 5 ft. and 7 ft. 6 in. thick respectively, for the medium and heavy case bomb of 500 lb. should preferably be a single slab. The one providing an air space between is difficult and costly. If an air space of not less than three feet in depth were provided above a roof slab 1 foot 6 inches thick, the thickness of the main slab might be reduced by 1 foot. But the possibility of using such a protective covering in two thicknesses has been given up mainly for the above reasons.

Even those who feel that surface type of shelters with a sandwich type of roof protection is necessary to save the inmates from the shock wave effect of an explosion recognise a further difficulty.

If the bomb should penetrate right through the upper detonating slab and into the pocket before exploding, the tamping effect of thus confining the explosion between the two layers may have very greatly exaggerated effects upon the shelter structure beneath. Methods of providing against this danger by sectionalising the detonating slab do not appear to be satisfactory, mainly because the sections would be considerably less likely to withstand the penetrating effect of the bomb than a continuous slab.

Owing to the oblique angle of impact with a vertical surface the thickness of vertical walls is largely governed by the explosive effect of the bomb, instead of the total impact and explosive effect. For lateral protection over ground, concrete of special quality, adequately reinforced, 3 feet 3 inches thick is required.

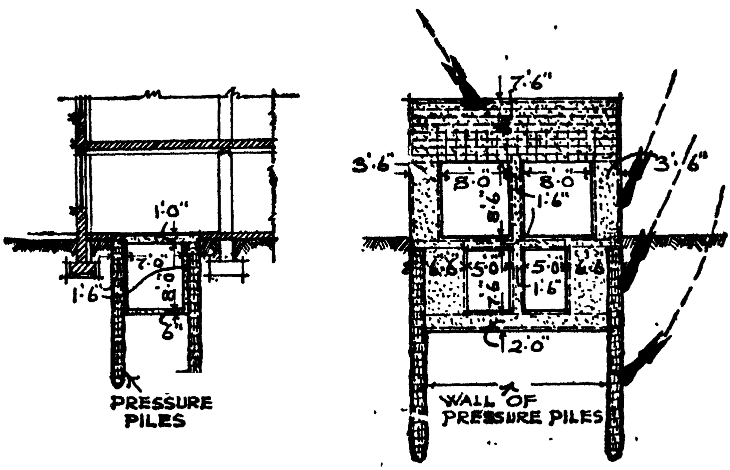
[1] A New York Engineer is reported as having claimed that from the point of view of protection from bombs, concrete is not so effective as cotton.

A 2,000-pound bomb falling 15,000 feet would penetrate six feet of reinforced concrete, he says, whereas a bomb three times as heavy falling twice as far would not penetrate a seven feet thickness of raw cotton. And the material could be made fire-proof. "Hindu" 10-8-1941.

[2] See A.R.P.H.5a. " Bomb Resisting Shelters ".

If the explosion occurs at or above ground level and on the surface of the protective wall, the explosion is untamped and the effect considerably less than if the bomb explodes below ground or after penetration of the concrete slab. Wall thickness below ground must, therefore, be greater than above ground, owing to the tamping effect of the soil when a bomb explodes near the surface of the wall below ground. Since the bomb is unlikely to penetrate the wall it is unnecessary to apply the value for the radius of rupture in concrete corresponding to the explosion of a charge well tamped within the surface of the concrete. The appropriate degree of lateral protection below ground is offered by concrete of special quality, adequately reinforced 6 feet 6 inches thick. Where the clear span between adequate buttresses is not more than 10 feet or where in a circular shelter the internal diameter is not more than 30 feet, the wall thickness below ground level may be reduced to 5 feet 6 inches.

Owing to the considerable depth of penetration of medium-case bombs into the ground and to the possibility of a bomb pursuing



With pressure piles used as an alternative

a curved path through the ground, it is necessary to provide for the contingency of a bomb exploding under the base of the shelter except at points well within the periphery of the vertical walls. The standard thickness of base protection should be 5 feet.

It is important to remember that the soffit must be lined. In order to prevent spalling the lower surface of the roof slab should be faced with steel which should be anchored not less than 12 inches and should be not less than 3/16 inch thick in the case of flat plates. Alternatively a close mesh reinforcement, attached to the lowest layer of 3/4 inch reinforcing bars, may be used to prevent spalling. The width of the mesh should not exceed 1-1/2 inches, and its weight should be not less than 3-3/4 lb. per yard super. A similar protection is also required for the inner face of the external wall in addition to the normal reinforcement.

Since the use of exceptionally heavy bombs may wipe out the whole of the occupants of the shelter it is necessary that shelters with a roof slab 5 feet thick should not accommodate more than 400 persons, those with 7 feet 6 inches, preferably not more than 1,200 persons. The internal partition wall should not be less than 18 inches thick in reinforced concrete and shall be provided between each group of 200 persons.

The designing of air raid shelters in connection with a complete scheme for the civil defence of a city is " not an ordinary engineering problem.... It is rather a question of designing structures giving an undefined degree of protection against destructive forces about which very little is known." The only effective way of dealing with the problem is to devise a method by which emergency measures for immediate protection could be improved upon by gradual stages to reach a degree of protection which would suffice to resist the largest of the high explosive bombs used in raids."[1]

Shelter Equipment

It is estimated that the cost per person for the rectangular shelter for 200 persons would be about £25 9*s*. and about £21 8*s*. per person for the larger shelter for 1,200 people. Massive construction alone is not sufficient to assure " safety ". Sanitation and equipment are equally important. Insufficient ventilation, and inadequate equipment can do as much harm as a bomb. Shelters must present as small a target area as possible ; they must be as dispersed as we could afford, not to invite special attention from

[1] O. N. Arup.

bombers; they must be properly ventilated and equipped with proper entrances and doors, lighting and sanitation.

Regarding the target area we should remember that it is not necessarily the same as the floor space required for inmates. The target area can be cut down by arranging the shelter in two or three tiers or by halving the floor space by installing higher capacity ventilating plant.

Secondly, lest we should invite special attention and attempt of the bomber to a particular area, dispersal is necessary. No very great distance between shelters is required but they should be not less than 25 feet clear between external walls below ground level of adjacent shelters. Where more than 1,200 persons have to be accommodated and the construction of separate shelters is not practicable, the case should receive special attention.

The third factor in safety is ventilation and this is complicated by the necessity to make the shelters gas tight. "In the case of an unventilated shelter accommodating more than twelve persons intended to be permanently sealed against gas during the whole period of occupation, it must have for every person accommodated:—

not less than 6 square feet of floor area,

not less than 50 cubic feet capacity,

not less than 75 square feet of surface area of all walls backed by earth, other walls not less than 8½ inches thick, floor and ceiling or roof.

For the purpose of computing the floor area, when there are seats beneath which the floor does not extend (as in a shelter in the form of a horizontal tube), the area of such seats may be deemed to be floor area.

In the case of a shelter not intended to be permanently sealed against gas, and ventilated by the entrance and exit or otherwise efficiently ventilated by natural means, or by mechanical means at a rate of not less than 150 cubic feet of air per hour, per person, it must have for every person accommodated:—

not less than 6 square feet of floor area,
not less than 50 cubic feet capacity,
not less than 25 square feet of surface area of all walls backed by earth, other walls not less than 8½ inches thick, floor and ceiling or roof.

The following table summarises the requirements prescribed by the Home Office of Great Britain.

Period of occupation	Unventilated gas-tight shelters—total surface area required, per person	Mechanically ventilated shelters	
		Total surface area required per person if shelter is ventilated at the rate given opposite in column 4	Ventilation rate per person
1	2	3	4
		30 square feet if shelter is above ground	450 c. ft. per hour
3 hours	75 square feet	40 square feet if shelter is above ground, or 20 square feet, if the shelter is underground	150 c. ft. per hour
12 hours	100 square feet	50 square feet if shelter is above ground, or 25 square feet, if the shelter is underground	450 c. ft. per hour

Provided that the floor area, capacity or internal surface area of any such shelter may be of less extent subject to the following conditions—

"That the shelter is ventilated mechanically at a substantially higher rate than the normal (exceeding 450 cubic feet of air per hour for every person in the shelter) and provided that satisfactory arrangements are made for emergency operation of the ventilating plant, when it will be sufficient if there is a floor area of 3¾ square feet for every person in the shelter."[1]

[1] "Air Raid Shelters for Persons working in Factories, Mines and Commercial Buildings." Revised Code. August, 1939. Home Office Statutory Rules and Orders, 1939, No. 920. Also Memorandum on the Revised Code "Air Raid Shelters for Persons, etc."

Some of the six hundred people who were killed in a Chungking air raid shelter when the ventilating system failed

Interior of an air raid shelter at Wimbledon made of precast concrete segments

" The comfort of the occupants of a shelter depends to a certain extent on the degree of ventilation, *i.e.*, the rate at which the air is removed and replenished, but to a much more important extent on the rate at which the bodily heat of the occupants is removed. Thus a greater degree of discomfort results from a rapid rise in the temperature of the shelter than from the vitiation of the air."

The dissipation of the body heat emanating from the occupants may take place mainly in two ways; by its absorption by the structure of the shelter, and by the removal of the heated air by ventilation.

As pointed out by a London doctor recently in the 'Lancet', people who have been compelled to spend many hours in air raid shelters have suffered illness, not so much from epidemics of colds, sore throats, skin. diseases and other complaints against which thorough precautions have been taken, but from pulmonary embolism.

This is a condition in which clots of blood form in the arteries of the lungs, usually of elderly people inclined to stoutness, and it sometimes proves fatal—deaths from this cause are reported to have increased sixfold in Britain since the outbreak of war. It is said to be brought on by long hours of sitting or reclining in the refuges from enemy bombing.

The shelterer sits in a deck chair or similar seat, the front edge of which presses into his legs, compressing the veins and causing first obstruction, then stagnation of the blood, followed by swelling and finally clot formation.

More space is required in shelters to prevent this. People who are compelled to spend long hours in air raid shelters should lie down at full length. The provision of bunks in many of the public shelters in Britain has reduced the number of fatalities from this complaint.

Where there is not an efficient system of natural or mechanical ventilation (and it must be remembered that when a shelter is " gas-proofed " the natural system is put out of action) conduction must be relied upon to rid the shelter of superfluous heat. For this reason the heat absorption capacity of the walls, floor and roof of a

shelter is an important factor in the determination of the permissible accommodation. In the absence of sufficient ventilation, the necessity for the conduction of the internal heat to the earth cannot be over-emphasised and it is rarely advisable to cover the lining and floor with heat-insulating materials.

There are two main conditions of ventilation for shelters to be considered. The shelters may be entirely sealed for the duration of an air raid against the possible entry of gas, by air-tight doors and with air-locks at the entrances. An air-lock is simply two gas-proof doors or curtains 4 feet or more apart, with a space between them sealed like a refuge-room. Persons can then pass through without admitting gas, provided they close the first door or curtain when they are inside the air-lock before opening the second. An air-lock at the door of a communal refuge-room or at main outer door or in a corridor used frequently is a great advantage. In such cases it may be useful to provide mechanical ventilation with some form of manual or pedal operation as an alternative to the normal power supply which might fail in an emergency.[1] With gas-tight, mechanically ventilated shelters it is important that the incoming air should pass through a filtration unit capable of removing war gases and, as an additional safeguard, the air inlet may be situated at a high level. With sealed shelters, not mechanically ventilated, it is necessary to limit the number of occupants.

In the second condition shelters will not normally be sealed against gas and their entrances and exits will be left open whilst they are occupied. Should gas be released in their vicinity the openings would be temporarily closed by blankets or similar devices, and the shelters would be evacuated when the attack was past. When normal entrances and exits of shelters are left open the bodily heat of the occupants will set up air convection currents which will normally suffice to ventilate the shelters when continuously occupied.

[1] World's best air raid shelters are in China's wartime capital. A tragedy in Chungking's air raid shelter cost hundreds of lives. In world's largest dugout (estimated capacity: 30,000) hundreds of Chinese died. They died not of bombs but of suffocation, in mad frenzy, as they clawed and tore at each other to fight their way to fresh air. In one of the longest (five hours) air raids in Chungking's three years of experience, the dugout's ventilation system had failed.

The thousands within had grown restive, then in panic had tried to force their way out all at once through the narrow twisting slits in the rock. Last official count of the dead : 461 a full half season's toll in a single evening.

The confidence of Chungking's fighting little men in their Air Raid Protective system still the world's best was, however, shaken.

With the increase in the air strength of nations waves after waves of raiders coming in succession has become a possibility. For instance during the close of January 1940, when the Russian Air Force raided Central and Southern Finland " Large sections of the population have been forced to spend many hours in air raid shelters." Helsinki had six air raid warnings during one day, forcing civilians into shelters for several hours. Several births and deaths took place in them. High officials have been forced to stay in shelters for long hours in China. A shelter will have to be very much larger to accommodate a given number of persons if there is no provision for mechanical ventilation, and considering the enormous cost, the latter is to be preferred. The advantages claimed for it are:

1. It reduces the size of shelters to one quarter of what it would be if unventilated.
2. Constructional costs are proportionately reduced.
3. Vulnerability to explosion and gas is lessened.
4. They make shelters an economic possibility.
5. They will help to combat panic, because plenty of fresh air for the occupants will help to relieve the strain on nerves; also, more people can be accommodated in well-ventilated shelter.

Shelters are kept in a comfortable liveable condition for an unlimited period for any required number of persons by ventilating plants.

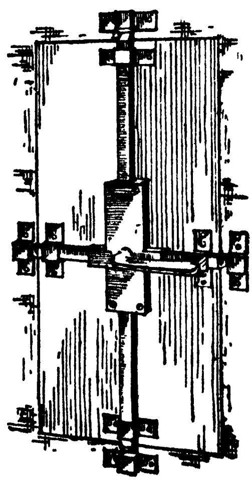
The basic principle of these gas filtration and ventilation sets for shelters depends upon the use of small compact apparatus consisting of a fancasing of special design, and connecting steel duct. In the casing the activated carbon is packed, along perhaps with other material such as porous paper and the fan sucks in air from the outside, contaminated with gas, which is then passed through the apparatus and the poisons absorbed, the purified air being discharged into the shelter, which has an outlet to the atmosphere fitted with a non-return valve. They are also provided with a small electric fan and there is also large crank handles, so that if the electricity is cut off during an air raid then the fan can still be worked by one or two people inside the shelter.

The latter is also provided with refrigerator type of door constructed of wood and having rubber tubing fixed all round,

laid in grooves, so that when the door is shut with refrigerator handles the rubber makes an absolutely gas-tight joint.

The principle adopted in gas filtration plant is the same as that used in gas mask. Activated carbon combined to some extent with special varieties of porous paper is used. The former is a variety of almost pure carbon somewhat resembling charcoal but enormously increased in absorbent reactivity for a wide range of gases and vapours. There are a large number of varieties of activated carbon made in different countries. But the details are supposed to be more or less a secret. Their minute cells almost atomic in size, actually liquefy the gas and retain it in the liquid condition, and until methods are discovered to make possible the use of poisonous gas that cannot be easily liquefied, such as carbon monoxide, these plants might be useful.

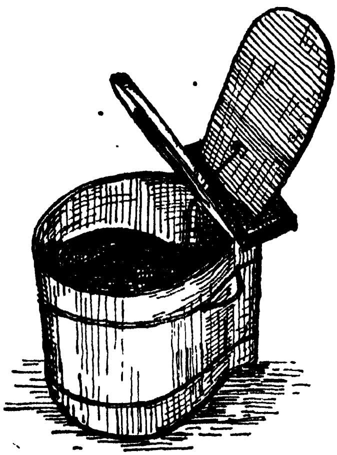
Blast splinter and gas-proof doors are required to render shelters safe and steel is the material generally recommended both for doors and shutters. Gas-proof steel doors equipped with clamping handles or double operated bolts for operation on both sides can efficiently resist blast and splinters. An observation window is provided. Window shutters are similarly provided and steel plates of desired thickness is used to overcome structural difficulties by manufacturers specialising in pressed steel plates. The principle underlying safety lies in heavy four-way bolts to wedge them at four points, as shown in the adjoining illustration: The keyhole is also covered outside preventing insertion of key or entry of gas into the shelter. Strong lever handles operate latch bolt and when engaged the door is tightly drawn into frame. The thickness of the steel plate varies from $\frac{5}{8}$ of an inch to $\frac{1}{8}$ of an inch according to the degree of protection required.



Blast, splinter and gas-proof shelter door

Some of their features are patented but in essence conform to the Home Office Specifications of height and breadth, the provision of a gas-tight spyhole and a gas-tight frame. Doors calculated to resist direct hits are not commonly sold in the market. A popular model consists of solid framed and laminated red cedar, made fire resistant. The fastenings are heavy refrigerator type and the door is gas-proof by rubberised linen. Thermite-proof panel or steel-sheet is fitted to face. Gas-proof observation panel of double reinforced glass bedded in rubber is provided. The price ranges from 87 shillings.

Every air raid shelter must have proper closet facilities at the rate of not less than one seat per 25 persons accommodated, and also such subsidiary buckets and urinals as may be necessary. Such conveniences must, where practicable, be contiguous with the shelter and divided therefrom by a partition extending the whole height of the shelter. Here again the need for gas-proofing leads to complications. The usual varieties do not suffice. The type considered most suitable depends upon the use of chemicals to deal with deposits and decomposition. The chemicals supplied along with the set sold by manufacturers immediately deals with deposits and decomposes them. An anti-splash tray is fitted and is automatically flushed. A separate container is also provided to enable refuse to be easily removed. They remain perfectly hygienic independent of outside drainage which would be vulnerable to air attack. The sewage disposal is postponed without risk of odour or infection. A closet for 20 persons occupies one square foot and for 30 persons 2 square feet. These chemical closets which fulfil the needs of A.R.P. sanitation, for women as well as for men, range in price from 50 to 60 shillings. It is claimed that maintenance cost is extremely low.



A typical chemical closet

There is also the problem of drainage especially for shelters with decontamination units. Pumping out the water is necessary, if shelters are sunk below ground level. As this is not convenient deep underground shelters are not recommended.

" Every air raid shelter must be adequately lighted, and a system of independent lighting must be installed sufficient to afford such light as may be necessary in the event of the failure of the normal lighting service. Where generators or large storage batteries are employed for such purpose, they must be isolated and have separate ventilation.

" Pipes, tanks or containers which might prove a source of danger (such as pipes or containers conveying or holding steam, gas, compressed air, refrigerants or noxious chemicals) must not be permitted in any air raid shelter, and water pipes connected direct to the mains or to large supply tanks, and gas pipes, must be provided with such valves as may be necessary to permit of their being isolated where they pass through any shelter.

" Where water-mains or sewers are of such size or in such proximity to an air raid shelter as to be hazardous such provision must be made as may be necessary to exclude their contents from the shelter in the event of damage."

The question of shelter lighting has received ample attention and the British Standards Institution have prepared their specification at the request of the Home Office. The point stressed, however, is to ensure emergency lighting by a standby equipment to be worked by man power when electricity fails by bombing to come up into operation upon partial or complete failure of mains.

To protect against gas and to help decontamination as far as possible walls, particularly the lower 6 feet, should be finished with impervious material which can be washed and decontaminated. Very few materials comply with this recommendation and at the same time are proof against acids, gases and the like used in modern chemical warfare. Mustard gas, phosgene, lewisite, chlorine or hydrocyanic gas readily attack building material containing lime, especially cement and plasters, which readily disintegrate in their presence. Slate is recommended as the most economical material and it also gives structural stability for it is almost free from calcium

in the form of lime in chemical composition. Other measures are also recommended. Non-absorbing paints are suggested for painting shelter walls.

To make shelters efficient particularly when they are large, first-aid rooms, cleansing facilities and even kitchen would become necessary and such provision has been made in some of the shelters in Europe. Recent air raids over England demonstrate that people might be forced into shelters for long periods sometimes compelling them to sleep in them.

Since Hitler launched his big-scale offensive against England during August 1940 London has spent up to December 1940 a total period of 1,056 hours or six weeks under air raid warnings. A *Reuter's* correspondent keeping a daily log of the alerts says that the capital has had nearly 400 day and night warnings, ranging in time from a few minutes to an all-night alert, lasting over 14 hours which is the longest recorded so far, although the greater part of 24 hours has frequently been intermittently under warning.

In almost every big shelter in London, there is now a "miniature hospital" and some shelters have a resident or full-time doctor. Over 200 doctors pay nightly visits and nearly 300 more are available if called. The transfer of nearly one million mothers and children from London and big cities has also been a complex problem which has been carried out with considerable success.

It would seem to be necessary for the populations of the majority of our large cities to spend at least a considerable part of each 24-hour day in shelter, often during the time when bodily resistance is most lowered by fatigue resulting from the day's work. The adoption of suitable principles of shelter design to minimise both the occurrence and spread of disease may well, in the course of time, become almost as important a design consideration as providing protection against attacks with high explosive bombs.[1]

All these are necessary to ensure safety to inmates and make their stay possible. It is, therefore, considered that large shelters alone are advisable.

A careful study of the relative advantages of the large communal type of shelters and the small domestic shelter reveal that large ones

[1] "Builder", Jan. 10, 1941, p. 32.

are considerably more economical than dispersed shelters and therefore even the same expenditure per head will make possible a much higher standard of protection.

They can be readily provided with lighting, sanitary conveniences and furniture, and existence in them can be made reasonably comfortable.

More important than all these is this consideration, namely, in the most vulnerable areas, *viz.*, the centres of large towns and cities, for a large proportion of the population, it is not possible to provide any of the various "dispersed" or "family" shelters. This is, in the main, due to lack of sufficient space immediately adjoining each house, although flooding and unsuitability of site generally are contributory factors.

Finally as the A.R.P. Co-ordinating Committee points out, large communal shelters can be built in two stages; immediately blast and splinter-proof and strengthened later to resist direct hits. It thus solves the problem of combining an immediate and long time policy for partial and absolute protection.[1]

Small bomb-proof shelters cost very much per person but have been erected in important centres. A bomb-proof shelter for 25 persons, which can be used as a strong room during peace, has been erected for a public authority in Westminster. The floor area available measures 12 feet by 8 feet. The height is 7 feet. An air-filtration plant is installed. There are two sumps, a water tank, two gas-tight doors, a telephone and an emergency exit. The shelter is approached by a flight of steps through an air-lock 3 ft. 2 ins. wide by 6 ft. long between the two steel doors. The reinforced concrete walls and roof are 5 ft. thick and the door is 4 ft. thick. Above the roof is 2 ft. of soil, which has been turfed over. The underside of the roof is lined with Lewis dovetail sheeting.

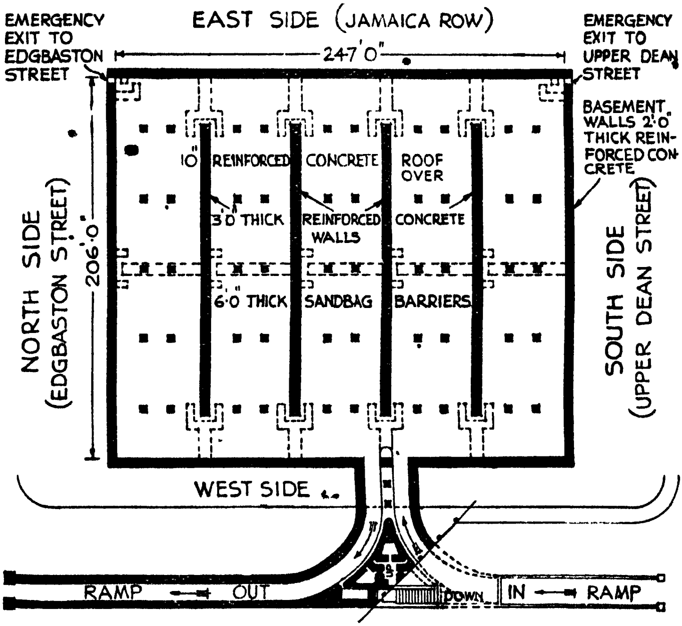
Seats are fitted against the walls, and the authority's documents can eventually be kept in steel boxes 1 ft. 6 ins. wide stored under the seats and over the heads of those sitting in the shelter. The height between the top of the seat and the underside of the upper

[1] For details of the scheme see extracts in "The Builder," Dec. 22, 1939, pp. 852 854.

shelf carrying the steel boxes is the same as the height of a standard filing cabinet.

Shelter Economy

Those who defend the policy of blast-proof shelters for every home point out that bomb-proof shelters are expensive and impracticable. This is based on the assumption that during peace they are useless.



The Birmingham underground car park and air raid shelter

The shelter for 3,500 persons erected in Birmingham[1] and the proposals made elsewhere disprove this assumption. A large air raid shelter in a busy area, convertible into a garage, solves both the problem of congestion and finance. A peace-time use can make expensive shelters economic and the Birmingham example is illuminating. This local authority made arrangements for the adaptation in the plan stage of an underground car park—for 260 cars—under the new St. Martin's Toll Market. In the space of a

[1] Birmingham Underground Car Park Scheme J. T. P. I., Dec. 1938, pp. 75-76.

few minutes the car park can be converted into an air raid shelter capable of accommodating 3,500 persons.

The entire scheme, including the market hall, underground car park, air raid shelter, and a two and three-storey building for shops is of reinforced concrete.

A total floor area of 5,800 sq. yds. has been planned for the car park, which will be 250 ft. long and 209 ft. wide. Entrance and exit are by inclined ramps on opposite sides 10 ft. wide, with a gradient of 1 in 9. They connect the car park to the new road by a tunnel running underneath the street. Emergency exits are provided for use in case of fire or as entrances when the building is used for air raid precautions.

Reinforced concrete walls, 3 ft. thick, will divide the park into five sections, and arrangements have been made further to divide each compartment into two sub-sections in time of emergency. This will be effected by the erection of sandbag barriers 6 ft. thick, thus providing ten separate self-contained compartments 100 ft. long and 47 ft. wide, each of which will accommodate 350 persons.

The reinforced concrete walls to the basement of the market hall are increased to 2 feet 6 inches in thickness, and the roof of the car park, which is the floor of the market hall, is divided into reinforced concrete panels 10 inches thick; these panels are expected to provide protection against incendiary and small high explosive bombs. The system of division into ten compartments ensures, in the event of direct hit, that the number of casualties will be reduced to minimum. It is emphasised that it is not sought entirely to prevent the roof being penetrated by heavy bombs, but rather to localise their effect should they reach the basement.

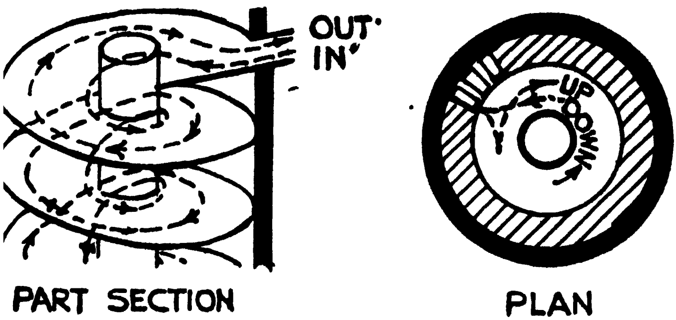
A ventilation system is provided for, to extract car fumes at ground level and supply fresh air, while movable screens are provided to isolate cases of fire, and the concrete floor grooved and sloped to aid escaping petrol. In time of war the ventilating system would be reversed to maintain a slight pressure of air inside the shelter.

It is expected that the erection of the building will aid the reduction of traffic congestion in Birmingham by taking 260 cars off the city streets. These cars will be parked under a system which

will obviate the handling by attendants, while movements of vehicles will be facilitated by placing the columns of the building 37 ft. 6 in. apart, giving a depth to the wall of 16 ft. on either side. Central gangways are 15 ft. wide, and a system of one-way traffic will operate, cars being parked within sections denoted by white lines marked on the floor.

Total estimated cost of the air raid shelter and car park is £48,000 of which £7,000 has been allocated for the adaptation of the car park for air raid precautions, with a possible further £6,000 for air-filtration plant.

A convertible car park and air raid shelter has also been suggested under the Russel Square in Holborne.[1] Another useful variety is the multi-storey garage triangular in shape. Some idea could be had from the plans prepared by the joint effort of well-



Another type of car park and air raid shelter

known experts in their particular subject. This will serve as a modern up-to-date garage in peace time, and could be converted on the possibility of war into an Air Raid Shelter, Decontamination Unit and First-Aid Clearing Station. It could be erected on a site chosen as a detached building and if possible of a shape to avoid right-angles.[2]

It is a ferro-concrete structure throughout, including the external walls, the external walls themselves also to be faced with 4-in. stone supported by the concrete construction with 2-in.

[1] For plans and sections see the "Builder", Jan. 6, 1939, p. 9.
[2] The "Builder" A.R.P. Supplement—Feb. 24, 1939, p. XVI.

hollow space forming an air cushion behind the stone as provision against blast.

The floors are arranged to make it possible for ramps to be used as a means of access from floor to floor. In addition, there is a central stair-case and a lift. The whole of the inside of the building is left, with bare concrete to be distempered and the structure throughout will be of the most economical kind except that special provision is made by means of properly constructed steel shutters, so that all windows and openings can immediately be sealed against attack.

Of necessity provision must be made for additional electric and other services, which would be essential for war conditions.

To provide quickly for the building to be divided into several units in war time, special metal divisions and shutters should be provided and housed in the basement until required.

In case of any breakdown in the electric services a standby electrical installation is necessary.

Lock up shops could be provided where there would be demand.

The roof is specially designed to resist the small bomb and incendiary bomb.

The upper floors, in case of a raid, are to be used as the air raid shelter and provision is made for sanitary services, also for kitchens.

The ground floor and the basement floor will be used for the Decontamination Unit and the First-Aid Unit. The Decontamination Unit is complete in itself with separate access to First-Aid Unit and the shelter above.

Apart from the Decontamination Unit there is a separate entrance on the ground floor for those going to the shelters on the upper floors, and separate entrance on the other side of the building for the cases arriving for the First-Aid Unit. In this Unit the male cases are dealt with on the ground floor and female cases in the basement. In the basement, in addition, two 20-bed wards are provided, one for male and one for female, with services and nurses' quarters.

Both in the male and female First-Aid section is provided a small operation unit with anæsthetic room, theatre and sterilising room; the whole building will be air-conditioned by means of plant placed on the roof, adequately protected.

A number of towns, including London, are adopting this sensible principle of erecting dual purpose air raid shelters which in the future will form underground car parks, in which connection of course a substantial Treasury grant is obtainable, as with most public air raid shelters.

In the May 1940 issue of "Concrete and Constructional Engineering," there is described, with detailed drawings, a scheme for a car park and air raid shelter, below the ground level, at Kingston-on-Thames, which is a fine example of what can be accomplished in this connection. This is a concrete building consisting of six adjacent bays each 107 ft. long, which has cost £8,000, and will, in the future, after the war, be converted into a car park at an initial cost of about £500. Accommodation in the shelter is sufficient for 1,200 persons and the accessories are of a very complete character, including water-supply, drainage, lavatories and lighting. When used as a car park the accommodation will be 174 cars and the space above, constituting a flat roof, level with the ground, will be converted into public gardens.

Another small shelter for 170 people is in the form of a reinforced concrete building with the floor, walls, and roof designed as a cellular raft to carry the heavy load represented by the erection in the future of four storeys upon it. The space allowed is 3.75 sq. ft. per person with mechanical ventilation, the plant for this latter purpose having cost £100. For use as an air raid shelter it is fitted also with stand-by lighting, lavatories, and other accessories, and has cost £875, whilst for ordinary peace-time use it will be fitted with racks and bins and used as a fire-proof store-room for inflammable oils.

Another dual-purpose air raid shelter is at a large factory, built entirely of reinforced concrete in three storeys, one of which is below the ground. The latter constitutes the main shelter whilst the ground floor is used for first aid and decontamination, and partly as a shelter, and the second storey forms a third emergency shelter. The total accommodation throughout is for 300 people. When the

war is over this heavily built shelter will form a works canteen on the first floor, a cycle store and two garages on the ground floor and an engineer's stores in the basement, the total cost involved having been £2,500, which, however, includes very elaborate equipment such as drainage, water-supply and electric lighting.

To residential zones where convertible garages are neither necessary nor paying, community centres capable of conversion into air raid shelter during emergency has been suggested.[1] The primary purpose of the building is to be a centre suitable for use by the various bodies engaged in social work, musical and operatic societies and local gymnastic and physical training clubs. It would also provide accommodation for the local voluntary fire brigade and also committee rooms which are for use of local bodies for various purposes. The organisation to be built up for A.R.P. purposes could usefully be housed in the same building as an A.R.P. centre and first-aid post without involving any structural alteration.

The structure may be of ferro-concrete frame and roofs faced with brick. The roofs must be flat, with parapets on all sides to facilitate protection by sandbags when the necessity arises.

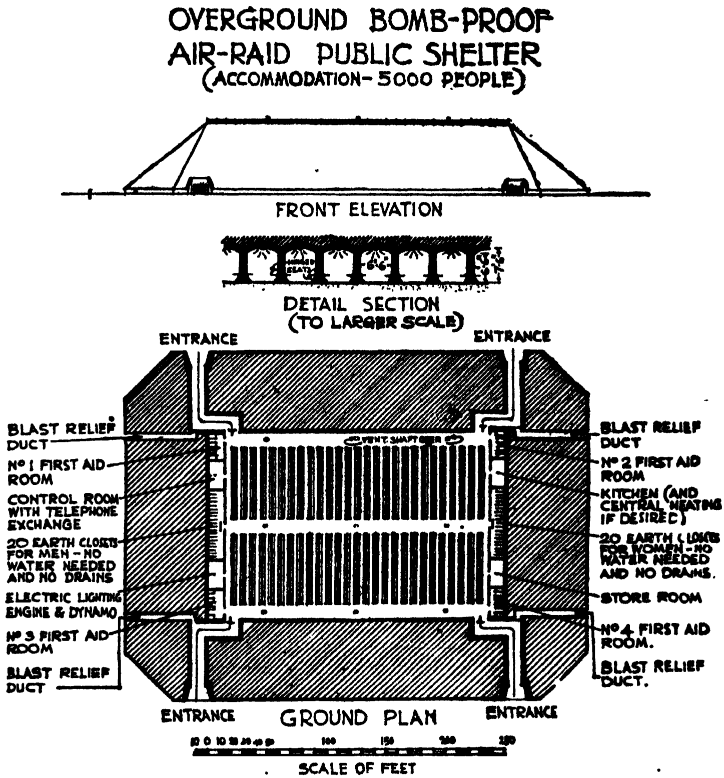
Further people could accustom themselves to the idea that in times of crisis this is the building to which they should apply for advice, instruction and possible treatment.

It is considered that the psychological effect of this permanent provision of such facilities should be very valuable. It is estimated that the cost of such a building will be about £10,000 in Great Britain.

The plan for an overground bomb-proof air raid shelter given in the next page needs careful consideration. With suitable modifications it would ideally serve residential areas in any properly zoned and laid Indian city. It is entirely above ground, with no stairs, no flood risk, no interference with any underground sewers or pipes. It has scope for ample natural ventilation and unobstructed and ample entrances at all four corners on the ground level. Built of common bricks in lime mortar with reinforced arches and lime washed inside with a solid earth cover 20 feet thick

[1] *Ibid.*, p. 16–20.

it is on a 2½-acre site which includes spaces for terraces of flats on the four fronts of the grassed mound.[1]



This would offer accommodation for 5,000 people. The cost estimated in England is £5 per head and it would be less in our country. The internal arrangement consists of separate tunnels interconnected by three transverse tunnels. Where the density of population is 100 persons per acre, each shelter would serve 50 acres or a rectangle of 1,524 ft. × 1,434 ft. The distance from extreme boundary of area served by each shelter to shelter itself will be 191 yards and it could be reached in approximately 2 minutes. ' The 5,000 people on a 50-acre site can all reach the shelter within

[1] See "Builder" Supplement, March 24, 1939, p. 26 for Ground Plan and Elevation; Supplement, May 26, 1939, p. 35 for perspective view and details.

two minutes.' Kitchen store room, power room, control room, etc., are all possible. The two-and-a-half acre site permits the addition of 48 good shops (or garage accommodation for 400 motor cars, all on ground level) with 96 good flats above ; and as the top of the one acre mound could be used as a communal playground this feature would be very attractive to tenants. It is considered that building societies would find them attractive and paying.

Location and Accessibility

Thoughtfully located garages and carefully laid out community centres capable of conversion into air raid shelters would successfully meet the other argument that large communal shelters are not accessible and streams of people running towards it would be caught in a raid and perish. The Home Office prescribes :

> Every air raid shelter must be boldly marked and so situated and accessible by day and by night that the persons for whose protection it is intended may from the place where they work get into their shelter within seven minutes.

Further every large air raid shelter must have at least two exits as remote as may be practicable from each other, one of which may be the normal entrance if suitable.

The question of accessibility leads to the problem of adequacy. For, to be accessible to all the citizens there must be enough shelters. Further, unless a reasonably high proportion of the people can get into these, before bombing begins a frightened population may crowd the streets and cause panic while masses of shrapnel and pieces of anti-aircraft shells begin to fall seriously hindering fire engines and ambulances from fulfilling their necessary duties.[1] The authorities will have to face a double task of looking after the bodies and minds of the survivors as well as salvaging the devastated areas. In the main streets of Barcelona a shelter is said to be available at every 200 yards which must have contributed largely to the civilian resistance. And again they must be known and be familiar to the public. In Germany adequate precautions are taken to familiarise the citizens

[1] "It should be borne in mind that any policy should apply to the whole population of a district ; any scheme which protects only a part of the population can be shown mathematically to give a poor return for the money spent, quite apart from any consideration of fairness." O. N. Arup: *Vide* Ante.

with their location, by permanent signs and notices and this is necessary especially if air raids happen at night.

Protection to people is possible only by massive structures that could resist the high explosive, the incendiary bomb and poison gas. Considerations of safety leads to large initial outlay but proper design can render such schemes economic and practicable. But adequate numbers should be there to make them accessible. The lay-out of modern cities require too many to provide this facility for all inhabitants. Crowded and congested areas would not only make their erection impossible but access difficult. With business, commerce and residences mixed together without zoning more numbers would be needed for the population than we can build if they were properly distributed. To economise in the number of shelters it is possible only if business houses and residences surround dual purpose air raid shelters. An altered lay-out zoning and planning of residential suburbs are necessary to make protection possible to all. The problem is therefore complementary to Town Planning, for this alone can meet the objection put forth against communal shelters by the advocates of partial protection, namely all cannot use them and have access to them.

Bomb-proof shelter in a residential zone

Until cities are reformed, caves, underground passages, tunnels in hill sides and natural shelter existing around vulnerable areas should be explored to render them fit for occupation during raids. If Chungking has used her hills to provide air raid shelters to her citizens, the citizens of Detroit, the motor car engineering and ship building centre, are contemplating converting the City's old salt mines into air raid shelters for emergency. They occupy 160 acres at a depth of 1,100 feet. There are 25 miles of passage ways 50 feet wide and 22 feet high. The temperature is constant at 58 degrees. The entire population of sixteen lakhs can take shelter in them. The town might be bombarded and ruined, but the shelters would be safe.

The Finns have perfected measures to protect civilians and are giving the final touches to vast bomb-proof shelters blasted out of solid rock. One will house a complete hospital and another a fire brigade.

There are 3½ miles of tunnels, 60 ft. deep, in Southark capable of holding 60,000 people, 24 entrances with underground connecting tunnels permit everybody to be in the main shelter. Within 5 minutes of the alarm men, women and children eat and sleep here in complete safety. At a cost of £60,000 these shelters were erected before the war. Over 500 high explosive bombs were dropped during one raid alone. 1,000 houses were destroyed. But only 28 people were killed in the great terror raid.

The underground shelter is semi-circular in shape and accessible to everyone in 5 minutes. Every night men, women and children barring those employed in Civil Defence go " downstairs " to bed.

It is only right that nightly visits of Nazi raiders should lead people to a search for the deepest shelter, so a troglodytic influx to London's Tube Station platforms has resulted. Even the unused escalators are providing comfortless perches for shelterers. People begin to arrive as early as 4 p.m. with their bedding, and shopping bags filled with food. By the time the evening rush hour begins, they have already selected their pitches for the night. Business people, homeward bound, wave from the trains to the mothers and children. Some of the older children do their homework, using the platform as a desk for their copy-books. Later on, men, women and children remove their boots and shoes, and sleep in spite of the thunder of the trains. The L.P.T.S. have appealed to able-bodied men not to use Tubes as shelters. Although two Ministries have asked the public to use Tube stations as shelters " only in cases of urgent necessity," the natural instinct to seek the refuge of depth from indiscriminate bombing continues. The Ministry of Home Security has promised more and better night-time shelters. But the London Public is taking no notice, and is unlikely to leave the Tubes for surface shelters, or even for basements. The station platforms are filled to within a foot of the edge. The question of ventilation is one of the drawbacks of the Tube, in which the renewal of fresh air is dependent to a large extent on the passage of trains throughout the system. With people sleeping in an unused Tube, additional means of ventilation have to be considered.

CHAPTER IV

RESISTANCE TO STRUCTURES

CHAPTER IV

RESISTANCE TO STRUCTURES

A successful scheme of bomb-proof shelters would protect the people from air raids but life in the city would be impossible if the buildings that provide accommodation for living and work are rendered unfit for use, when they emerge from their shelters after a raid. If urban communities should stand a raid, city structures should be in a position to resist and recover from the weapons used. That is, they should be blast and splinter-proof; immune to earthquake effect and the dangers of demolition arising from the high explosive bomb; they should resist penetration and fire of incendiary bombs; as well as contamination from liquid gas. If this is not possible they must at least be capable of being rendered fit for use without great effort and expense. In short they must be in a position to recover from the blow easily. This should be considered more practical for from Chapter I it would be evident that total resistance is impossible until we cover the entire city with a reinforced concrete roof 7 feet 6 inches thick and enclose it by walls half that thickness. Absolute protection is uneconomic, but a fair measure of security could be obtained if city structures are so designed and located as to:—

1. render contamination of poison gas difficult and decontamination easy,
2. prevent the penetration of the kilo incendiary bomb and prevent or minimise the spread of fires caused by them,
3. prevent more than superficial damage to buildings by the high explosive bomb of 500 lb. weight.[1]

[1] T. E. Scott: "Structural Precautions in New and Existing Buildings." The "Builder", April 21, 1939, p. 744.

For liquid gas contamination for the structure of buildings the following treatment is recommended for decontamination :—

Material	Treatment for liquid contamination
Stone or brickwork	Hose down with water if this can be done before the liquid has had time to soak in, but not otherwise. Spray or brush surface with cream of bleaching powder and water. Leave in contact as long as possible (not less than 24 hours). Repeat treatment.
Concrete floors and tiles	Hose with water Apply bleaching powder and water cream and brush thoroughly over surface. Leave in contact for 6 hours. Hose with water. Apply sodium silicate solution, when available. Prolonged exposure to gross contamination may necessitate breaking up and re-laying floors in rooms which have to be inhabited.
Glazed tiles	Hose with water and treat with cream of bleaching powder and water. Give special attention to the joints.
Distempered walls	Paint or spray with paste of bleaching powder and water. Apply alternate layers of bleach paste and paper, and leave in position for at least 48 hours. Finally wash off and treat wall with fresh distemper or sodium silicate solution.
Papered walls	Strip off paper and then treat as for distempered walls.
Painted walls (wood or plaster)	If immediate treatment can be applied, that as for distempered walls and finally re-paint. If the contamination has been prolonged, remove the paint completely.
Wooden floors	Absorb visible liquid with fresh earth which should be burnt or buried. Scrub the surface with cream of bleaching powder and water, and sand. Leave bleaching powder in contact for 24 hours, then brush off and wash with water. Repeat treatment two or three times when necessary. Boards soaked in blister gas should be removed and burnt.
Unpainted woodwork	General treatment as for wooden floors. Hard wood articles and mouldings should first be swabbed with paraffin, and then treated with paste of bleaching powder and vaseline, which should be left in contact for a short period, and then wiped off, leaving a thin film on the surface.

Resistance to Gas[1]

Preventing contamination is impossible since building materials commonly used absorb liquid gas and a heavy spray or bomb explosion will bring the liquid in contact with them and even vapour would be absorbed though explosion may happen at a distance. As we cannot avoid brick, lime, concrete, and wood in our buildings the best remedy lies in designing the structures in such a way as to secure natural ventilation to prevent concentration of vapour and to facilitate washing them down thoroughly.

The interior should be as simple in design as possible. Mouldings, unnecessary fittings, etc., should be avoided. At least lower portions of the room should be constructed of smooth surfaced non-absorbent materials which can be readily washed and decontaminated.

Good ventilation is necessary to clear away concentration of gas, and particular care must be taken.

Flooring materials should be non-absorbent to blister gases and be capable of decontamination by the normal methods. Concrete with a granolithic or cement finish, and periodical treatment with sodium silicate solution is most suitable. Quarry tiles also provide a satisfactory material. But they should be set in cement mortar with a fine joint and treated as above. Unglazed tiles retain mustard gas. Rubber flooring should not be used as this material absorbs mustard gas. Flooring of an asphaltic or bituminous nature is also unsuitable.

Bare wooden floors, may be used but repeated decontamination will injure the timber, and preservatives and varnishes add no advantage.

Walls, as far as possible, particularly the lower six feet, should be finished with smooth surfaced impervious materials which can be washed and decontaminated. Glazed bricks or tiles of the best quality set in cement mortar with a fine joint are most satisfactory.

[1] This section is based upon A.R.P.H.1, A.R.P.H.4 and other H.O. publications.

Smooth portland cement and sand as well as plaster finishes of either lime plaster or gypsum plaster as practised in this country form a satisfactory finish which is improved by periodical treatment with sodium silicate solution. Corrugated galvanised sheets could be used, fixed with the corrugations vertical, with the joints done with special care.

Fairfaced brick work where ordinary building bricks are used is unsatisfactory. Wall finishings of an asphaltic or bituminous nature should not be used.

Wall linings and panelling of match-boarding, plywood, fibre board or asbestos cement sheeting are unsuitable unless all joints are covered and the whole finished with a varnished paper or a resistant paint coating to eliminate joints and porosity.

Mouldings and panelling should be avoided, and the angles between the walls and floor should be coved either with tiles or cement ; wood skirting should be avoided.

The use of paint is not desirable, because ordinary paints are not satisfactory. The use of materials which require painting should be avoided as much as possible. Even hard drying enamel paint under repeated contamination may prove dangerous.

Fittings should be reduced to the minimum and should be of the simplest possible design and where practicable must be situated on the upper half of the walls so as to be out of the zone of heavier contamination. Doors should be of the flush type without moulding or panels, metal windows should be provided. Hard ebonite materials are not recommended as they absorb mustard gas. Bakelite or Beatel Scarab ware are most suitable for fittings. Glazed porcelain is also satisfactory and metal pipes and fittings may be used but should be treated with a suitable paint to prevent corrosion by bleaching powder.

Methods of Decontamination for Household Articles[1]

Articles	Treatment
Furniture (hard woods)[2]	Swab thoroughly with paraffin, then give prolonged treatment (not less than 48 hours) with mixture of bleaching powder and vaseline.
Upholstery	All upholstery must be stripped from the wooden framework. In many cases it will probably be quicker and easier to destroy it by burning and replace with new material. When it is necessary to undertake decontamination, use the following methods :— Woollen fabrics—immerse in boiling water for 1 hour. Leather—expose for prolonged period in a current of hot air, but if heavily contaminated, it is safer to destroy by burning. Padding—Hot air treatment may occasionally be applicable but in general it will be safer to burn.
Bedding	Treat as for clothing according to whether textile is wool or cotton. Mattresses may be treated in a steam disinfector.
Carpets, rugs, etc.	If lightly contaminated hang in open air to weather for 7 days in mild weather, and 14 days in colder weather. If wetted with blister gas, spray with soda solution before hanging out to air to prevent tendering of the fabric. If carpets are heavily contaminated they should be destroyed by burning unless arrangements can be made to immerse them in boiling water for 2 hours.
Linoleum	If in good condition and only the upper surface is contaminated, treat with bleach and water cream. If it is worn and the basic fabric is contaminated, it is safer to destroy by burning.
Metal fittings	Swab well with paraffin or petrol and rub dry with clean cloths.
China glass and earthenware . .	Treat in boiling water or strong bleaching powder solution, or swab with paraffin or petrol, (swabbing not suitable for unglazed articles).

[1] *Vide* A.R.P.H.4, Appendix D.

[2] Owing to possible danger from personal contact with furniture hasty decontamination should not be attempted.

Oiled fabrics may be used but as they should be boiled to free them from gas poison, it is better to avoid them.

It is evident from the methods suggested in the above table that in addition to simplicity of design and construction and suitable materials, furniture and household goods should also be simple and few and of material easily washed and decontaminated. Upholstery, excessive bedding, carpets and rugs and wall paper and paint, are not suitable to resist mustard gas attack. But they are not needed in our country where climate is very kind. Simplicity is not inconsistent with comfort and furnishing our homes with furniture, utensils and vessels of the traditional type seems desirable if we should face this new danger.

Ventilation is as important as design, for when properly secured it would almost completely eliminate the danger from the non-persistent gases. It would help evaporation and weathering in the case of persistent gases. But care in design alone cannot help because ventilation depends also upon the location, the neighbourhood, the lay-out of the roads, etc. The best design will fail to succeed when these are unsatisfactory. An open lay-out and a road system that would help the breeze to " blow through " the streets and homes is also necessary.

Decontamination involves copious use of water, and need for it would be aggravated by the demands of fire-fighting if simultaneously incendiary bomb attack is made. Adequate water-supply should therefore be provided, but this is not enough. The washed water may carry contamination down the drain and wherever it spreads.

Care must be taken to ensure that the water can drain away satisfactorily to a place where it will not become a source of danger. It should not be allowed to flow into streams or ditches where the contamination might be carried to some place where it would be dangerous. If it flows into pools or ditches near at hand where it is considered that it can be allowed to remain, those pools or ditches should be marked as contaminated. Where there is nowhere for the water to flow away safely, the method of decontamination by hosing cannot be used, and alternative methods must be employed.

Adequate water-supply and drainage facilities are both required to enable hosing down to be carried out. If a gas attack should be prevented from rendering our city structures and buildings unfit for use, their design and construction should be improved, their lay-out bettered, road system rationalised, and provision made for adequate water-supply and suitable drainage. And this is especially necessary for residential areas where the use of gas is most probable.

Resistance to Fire and Incendiary Agents[1]

To render the incendiary bomb innocuous it is desirable to prevent penetration and check the spread of fire. Fire-proof materials in construction, fire breaks and ample water-supply are necessary to solve the problem successfully. The incendiary bomb is especially dangerous as is evident from the destruction of Warsaw and other European cities; and Spanish experience also tells us that fire-proof construction would reduce the danger very effectively.

It is very difficult to check the spread of fire once the incendiary bomb gets into the building and the most desirable measure is to prevent penetration by impact. Fortunately these bombs have poor ballistics, cannot be aimed accurately and hit the target perpendicularly. A resisting roof will largely solve the question and the following minimum thicknesses give the required protection, against penetration by impact of incendiary bombs of various weights.

Bomb	Rein-forced concrete	Sand*	Earth*	Shingle*	Mild steel plate
1 K. 2⅕ lb. ..	3½″ — 4″	6″	6″	6″	¼″
2 K. 4¼ lb. ..	5″ — 6″	3′ 6″	5′	—	⅜″
5½ K. 12 lb. ..	—	4′ 9″	7′	—	—
10 K. ..	—	6′	9′	—	1″

*About

Since the one-kilo bomb is most likely to be used, mild steel plate ¼ inch thick or one layer of sandbag (laid as closely as possible) or 3½ inches to 4 inches good quality reinforced concrete for the

[1] *Vide* A.R.P.H.9. Also Felix Samuely, the Builder.

roof would be enough. But considering economy, practicability and utility buildings with a flat roof 4 to 6 inches thick in reinforced concrete is preferable, both for domestic dwellings as well as for large buildings. For the latter type 6 inches might be preferred. Erecting pitched roof of combustible material and strengthening it in emergency is expensive and less effective.

The following materials give protection against burning of the magnesium (electron) incendiary bomb :—

Materials	Min. Layer ins.	Weight per. sq. ft. in lbs.	
Household ash	2¼	5	0
*Slate dust	1¼	5	0
Red Ash	1	6	0
Boiler House Ash	1¾	6	0
Refuse Destructor dust	2	11	5
Brick dust	1½	9	5
Sodium Bicarbonate	1	5	0
Kaolin	1½	5	0
Pumice (ground)	1¼	4	0
Dry (virgin)	1¼	6	0
Earth (sifted)	—	—	
Dry sand	1¾	13	5
†Foamed slag (ground)	2	5	5
‡Powdered chalk	—	—	
§Asbestos sheet ,, wood ,, wall-board (Types which do not fracture under heat) ..	¾	—	
Preparations of the plaster type made up mainly of ground rock anhydrite	¾	—	
Asphalt (certain types)	¾	—	

* As efficient as sand and lighter.

† Has advantages over sand (much lighter).

‡ Not recommended. It will react with the bomb.

§ ½″ gives fair protection.

To provide against burning, dry sand 2 inches thick, foamed slag 2 inches thick, household ash 2½ inches thick, earth 2 inches thick (reasonably free from vegetable matter) preparations, for instance, of the plaster made up mainly of ground rock-anhydrite, about ¾ inch thick asphalt (certain types) about ¾ inch thick are suggested but they must be carefully placed for a loose covering such as sand will be disturbed by the fall of a bomb and the protective cover

would be diminished. And this cannot be avoided unless we make the layer very thick which may be too heavy for the floors or roof to bear. Even to existing buildings dismantling the pitched roof and erecting a R.C.C. roof 4 or 5-inch thick is recommended to resist the danger and wherever possible this measure must be adopted, particularly for residential areas where incendiaries will be used, and people cannot afford to maintain expensive fire-fighting organisations. Fire-proof windows and doors are desirable, and external features of buildings should be of non-combustible material.

The menace of the incendiary bomb has resulted in a vast amount of research and investigation into the fire-resisting properties of various materials, and of the most interesting new publications in this connection has now been issued by the Linoleum and Floor Cloth Manufacturers' Association of Staines (Middlesex) and has been reviewed by the Technical Press. In the case of the ordinary thin wood floor an incendiary bomb soon burns through, and most fire-proof paints do not seem to be much of a protection. According to these experiments when the wood is covered with Linoleum the bomb will not burn through, although giving a very severe charring. Bombs resting on Linoleum cause no penetration for over five minutes, and tend to char the wood underneath in about 11 minutes. If thicker linoleum is used the resistance is much greater and it is not necessary to emphasise the importance of increasing resistance in this way since the fire brigade is given ample time to get on the spot and prevent any serious conflagration. Further plain cork carpet of only 6.55 mm. thick is stated to give the same beneficial results, and certainly in general it would seem that the menace of the incendiary bomb has been exaggerated, which seems to apply also to other sections of aerial warfare.

Wherever a resistant roof is not practicable as in the case of large factories, etc., or where the target is so important as to invite heavier bombs that will render 5 or 6 inches reinforced concrete ineffective, special attention should be paid to check the spread of fire. Fire breaks are necessary and distances between different types of buildings are indicated in the following table :—

Exposing Building	Exposed Building	Fire breaks (distance between buildings)		
		Dangerous	Moderately Safe	Safe
High Fire Risk	1. With roof and window drenchers, wired glass windows in fixed metal frames	feet 20 (30)	feet 30 50	feet 40 (70)
	2. Without the above	70 (80)	80 (100)	90 (120)
Low Fire Risk	1. As above	10	20	30
	2. As above	40	(50)	60

Note :—These figures presuppose an adequate fire-fighting service and a fair water-supply. Figures in brackets apply where there is no such service or supply ; figures apply only if exposed building is of fire resisting or of brick and joisted construction with slate or tiled (or better) roof, or of iron ; flying brands are not allowed for; heights of exposing and exposed buildings are taken as 50 feet. If higher, breaks should be increased by 5 feet for each additional 10 feet in height in case of either or both of the buildings ; in high risk areas where valuable buildings are situated close together and intervening roads do not provide satisfactory fire breaks, the following measures are recommended to provide some protection :—

1. Fit wired glass in fixed iron frames to windows.
2. Fit roof and window drenchers on the ridge of roofs and over every door and window.
3. Provide water-supply, adequate to enable portable directors to be used.

Incendiary bombs might be aided by high explosive bombs particularly in commercial and industrial zones with large and massive buildings and dangerous conflagration might be started. Even high explosives themselves could start an effective fire. In addition to fire breaks and open lay-out provision for adequate water-supply is essential. Proximity is a vital factor but an idea of the quantities required for different types of buildings could be had from the following estimates made by the Home Office :—

Class A.—2,700 gallons a minute.
For large business premises, warehouses, large works, shops and stores, munition stores and factories, aeroplane stores, docks, timber yards, railway depots, oil and petrol depots, refineries and similar risks.

Class B.—1,100 gallons a minute.
For small factories, medium-sized shops, warehouses not exceeding three storeys, store yards excluding timber yards, public garages, small oil depots and similar risks.

Class C.—250 gallons a minute.
For residential and small shop properties.

Tanks and reservoirs suitably placed both in residential areas and in other zones appear suitable because the requirements for decontamination may aggravate the need for water, and underground mains may get shattered by high explosive bombs.

An efficient road system is also necessary to resist and recover from the incendiary danger. Broad roads would help to provide fire breaks, and facilitate quick movement of fire fighting services. This is impossible in narrow streets blocked by debris and bomb craters and immediate attention so very essential will be prevented.

Resistance to Blast, Splinters and Demolition

The high explosive bomb is far more difficult to deal with than the incendiary bomb and liquid gas. All that is practicable is

1. to reduce the likelihood of total collapse in the event of part of the building being seriously damaged.
2. to reduce the amount of secondary damage to the building and to adjacent buildings caused after the explosion itself by flying missiles and falling masonry.
3. to ensure that the building will resist blast effects to the maximum extent possible with the form of construction used.

As the high explosive bomb will be selected for important objectives, large structures and strategic centres the problem of big buildings should be first considered.

To achieve this six factors need consideration.

1. The force of impact of the bomb upon the surface which is directly struck.
2. The force of the explosion throughout its immediate zone.
3. The pressure of air or suction caused by the explosion.
4. Vibrations set up through the surrounding ground.
5. The effect of large blocks of building material and fragments of the bomb itself being thrown about.
6. Fire.

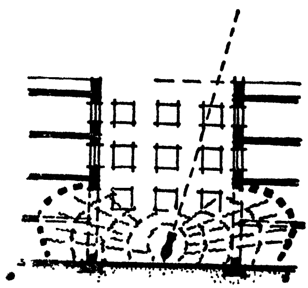
What type of building is best constituted to resist these forces and what special precautions should be observed in designing it? It is considered hazardous to lay down definite rules in the present state of our knowledge. Abstract theorizing may not prove useful. When all these forces act together the position is difficult to judge. But certain observations of the results of air raids during the last war, in China, Spain, Poland, Finland and Western Europe recently, enable a few guiding principles to be suggested which may serve as direction posts to the further study of the problem.

Framed structures have been able to withstand high explosive bombs better than unframed ones with load bearing walls. Direct hits were made on the Shanghai Administrative building by one-ton high explosive bombs but the damage rendered was more or less local. The building is of conventional design having reinforced concrete frame, and R.C. floors and roof.[1] Similar instances come from Spain. Photographs taken during the Spanish Civil War show the effect of direct hits on reinforced concrete frame buildings. The infilling panels give way, and some bays of the structures partly collapse but the edifices are not demolished.[2]

The fact is blast has terrific force and the lateral pressure exerted is so high that the walls get shattered if they are near. When those walls support the roof and the structure, their collapse leads to the destruction of the building. Separation of the load

[1] "Indian Concrete Journal," Oct. 15, 1939, p. XVII, XVIII.
[2] The "Builder," Oct. 3, 1939, p. 544.

bearing and enclosing functions of walls is absolutely essential if the destructive power of blast should be reduced. The infilling panels subject to damage or destruction could be replaced or repaired. This method is absolutely essential for large and multi-storeyed buildings in densely populated areas, industrial works, etc., likely to be the objective of repeated attacks, and where the probability of a direct hit or a nearby explosion, is greater. The maximum security against the effect of explosion is afforded only by a framed structure in which the walls are so constructed that they will yield readily to the air pressure resulting from the explosion of a bomb inside the building, and thus prevent injury to the structural framework itself and permit of the repair of the building in the shortest space of time.



Effect of blast upon walls of buildings in a narrow street

This does not mean that the safety valve type of walls must be fragile. A reinforced wall in which the reinforcement is not tied to the frame will suffice. But as such walls are liable to cause great damage in falling and parts of them are likely to form very dangerous and destructive missiles, it is better that the panels are of light construction. The danger of splinters is increased by thin panels but as high explosive bombs penetrate to the ground floor before explosion it is enough if the walls enclosing the upper floors are as light as possible. 13½ inches thick wall of brick or stone in cement mortar for the ground floor is considered suitable in the interest of safety.

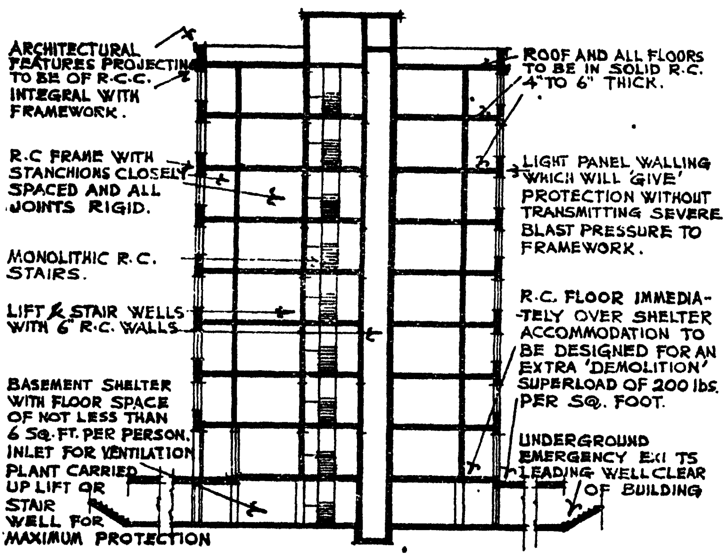
Research and Experiments Department of the Ministry of Home Security has issued a Bulletin (C18) dealing with " Recent Developments in Protective Wall Design for Factories".

Hitherto the commonsense form of protective wall has been built of 13½ inches brick, sometimes with pier buttresses of arbitrary height up to about 8 feet. Although such walls give protection to the standard for which they were intended, experience shows that when bombs explode near them they can themselves be a source of serious damage.

Much research has been done to design walls which will not only give protection against close explosions, but which will not form missiles or overturn on to nearby plant and workers. The relation between plant and processes and the walls to protect them has been studied. It has generally been found possible to take much of the sting out of enemy attack without seriously obstructing normal production.

MULTI-STOREY BUILDINGS

DIAGRAM ILLUSTRATING RECOMMENDED PRINCIPLES OF DESIGN FOR MAXIMUM STRUCTURAL A. R. P.



TYPICAL SECTION

It is not yet possible, and it probably never will be possible, to produce a universal guide to design, but rationally designed protective wall schemes are being tried in many factories. It is almost as common for explosions to occur at roof level as on or below floor level. Realistic protective design has to take this seriously into account.

A protective wall subjected to a near bomb explosion may fail by being shattered into fragments forming destructive missiles;

by overturning causing serious casualties to workers taking emergency shelter and in damage to plant; or by being blown bodily across the shop, sweeping all before it. The designs have been developed to lessen the possibility of these sources of failure. A principle of the design is that the resistance of that under excessive blast, the wall will bend over a comparatively short distance, without overturning or disintegrating. The wall consists of panels of reinforced concrete or reinforced brickwork spanning between steel verticals. These verticals are attached to feet in the form of spreader channels resting on or preferably sunk in, the floor.[1]

Cases have occurred in which panel walls built into the webs of steel stanchions (columns) have been subjected to severe blast and have bowed the stanchions (columns) out, shearing off their cap connections and producing collapse of the roof.

The ideal wall construction therefore consists of panel walls giving the code standard of lateral protection built independent of the steel framework so as to ensure that in the event of a near miss, they are blown in without involving the steelwork. This independence can best be achieved by casing the steelwork in concrete not bonded to the wall panels.

Careful designing of the roof is also essential but bomb-proof roofs are impracticable. Apart from the fact bombs may strike the walls, a very thick and heavy roof is a possible source of danger, as the impact shock of a large bomb might cripple the supporting member and bring the whole roof down. A number of solid concrete floors for cumulative stopping and bursting effect, is recommended as the better proposition, especially as some of them would probably be in the path of a bomb penetrating the wall obliquely.

A solid concrete floor with light reinforcement running both ways is to be preferred to a hollow floor of equal strength since they offer less resistance to penetration except at the joints.

Windows are very vulnerable. Hundreds of windows of houses and shops were shattered in a south-east coast town by the blast of four explosions. The roofs of some buildings were stripped, the blast carrying huge quantities of debris into the roadway. Several people were slightly injured by flying glass.

[1] *Vide* "Builder," August 8, 1941, p. 127.

Apart from direct hits, deaths and injuries caused by bombs arranged in order of their importance are glass splinters, bomb fragments, blast, and miscellaneous debris. There is no question of course that in modern civilisation the presence of glass is an extremely serious danger, so far as aerial warfare is concerned, even worse for example than the explosive and poisonous town gas represented by thousands of miles of mains mostly cast iron with rigid joints very easily fractured, resulting in many deaths from gas poisoning.

At the recent crash of a German aeroplane at Clacton most of the injuries were caused by splintered glass. Various measures have been recommended to prevent or limit this form of damage; and manufacturers are experimenting with new materials and with new types of windows designed to withstand the effect of bombing.

A London firm has produced a window claimed to stand up to a blast of 500 pound bomb exploding 50 feet away. Instead of a large sheet of glass, the window consists of many small panels, with cross-ribs of concrete. The glass, about an inch thick, is toughened by a special process and constructed of two lenses side by side. According to the makers, it provides a high degree of safety against small incendiary bombs, and is by no means inartistic.

Windows are a problem. The requirement for blast and splinters have to be compromised and they do not always blend happily. It has been suggested that windows should be rather at a higher level and be smaller or omitted if possible. This is desirable for the ground floor of multi-storeyed buildings, which could be used as garage. Blast and splinter-proof walls would make these garages fit for conversion into shelters, if other accommodation is not available.

Splinter-proof glass is now available and light need not be sacrificed for safety.[1] They could be suitably used to light the

[1] Glass considered brittle and unfit for use structurally during war times, has by recent improvements been made fit enough for war time use. Experiments carried out show that some forms of glass show considerable resistance to blast and glass bricks can be used where gas proofing requires windows should be closed without excluding light. In several London Hospitals windows opening on to landings where special protection is required have been partially bricked up, leaving a narrow vertical slit which is glazed with "insulight" glass bricks. It admits light and can be easily and cheaply blacked-out at night (for illustrations see "Builder," Nov. 24, 1939, p. 741).

(*Continued in next page.*)

blast and splinter-proof interior. Armour plate glass has been used in some of the hospitals in London. Lift stacks, staircases and store rooms could be effectively lighted this way and yet rendered splinter-proof which would be impossible by windows in general use.

To reduce the dangers of demolition and flying masonry from endangering the neighbourhood, a streamlined exterior is helpful. Or the projecting members should be such as being capable of getting tied to the frame. Open railings well anchored and stayed are to be preferred to solid parapets, since these are difficult to anchor, stay or buttress. But where solid work is to be used it should be reinforced, anchored, stayed and buttressed as solidly as possible. Coping stones are readily dislodged by blast or shock from blast and should be anchored down or linked to the vertical reinforcement in the parapet. External balustrades, balcony walls and the like should be strengthened if they cannot be omitted in the building. Open metal railings and balustrades should be used as they are safer, easier and more economical.

Canopies, balcony slabs and like cantilever features should be omitted since these are liable to catch the violent upward blast of nearby explosion ; otherwise they should be as small as possible, and more heavily reinforced, and well anchored to the structural frame.

Chimney stacks are not many in this country, but where they are to be erected they should be built against adjoining construction for the greater part of their height or else kept as far away as possible from adjoining buildings, so that should they collapse the damage will be kept to a minimum.

Incendiary bomb-resisting roofs cannot prevent high explosives getting through and starting an effective fire. It is necessary to adopt precautions to check the spread of fire. For it is impossible to make the contents of buildings all fire-proof. Both horizontally

" Armourplate " glass is blast-proof from 500 lb. high explosive bomb detonating at a distance of 50 feet. Triplex armour plate $\frac{13}{16}$ inch, of laminated design is bullet-proof, but affords considerable protection against flying splinters. The toughened lenses when used on concrete roofs withstand thermite and electron incendiary bomb and their heat.

The " Builder," Nov. 24, 1939, Supplement p. 17 for " Triplex " products. For insulight glass bricks and the view of the bricked up window at the St. Stephen's London County Council Hospital, see " Builder," Supplement, Jan. 21, 1940, p. 62.

and vertically the building should be divided with fire-proof barriers, into a series of relatively small cells, each capable of confining the fire, should the bomb explode within the cell. The design and planning of buildings should be such as to develop " a simple type of fire-resisting door which will be self-closing in the case of fire, but can be opened and shut in the normal way."

Designs for Factories

Single storey Factory Designs for war time have been issued by the Ministry of Home Security (Research and Experiments Branch) recently. According to this bulletin, the main object of air attack is to paralyse production. By dropping high explosive and incendiary bombs the enemy seeks to demolish or burn out factory buildings, ruin the plant and kill, maim, or at least demoralise the workers. Fortunately for the defence war time designs can do much to make factories highly resistant to collapse and difficult to fire; damage can be localised and the steadiness of the workers reinforced by giving them cover at hand.

Up to the present far more steelwork has been destroyed by fire than by high explosives.

The simplest way of minimising fire damage is to limit the combustible materials in the factory to the essential minimum. This applies also to the roof, where timber purlins or any form of slates or tiles on boarding should on no account be used.

The tendency towards very large buildings which is so marked to-day, should be reversed. It is preferable to subdivide a factory into as many units as possible, rather than to concentrate everything into one large building.

The first principle is that all loads should be carried by a framework of steel or reinforced concrete.

It is known that a reinforced concrete member is more severely damaged by a direct hit than a comparable steel member.

It may, therefore, be impossible to eliminate collapse entirely in reinforced concrete framed buildings. The evidence so far available suggests, however, that where reinforced concrete is used the most satisfactory way of minimising damage is to divide the framework into as many discontinuous units as possible, thus localising any collapse that may occur.

The second principle is that the steel frame should resist collapse notwithstanding the sudden removal of any one main member.

An explosion inside a factory forces the roof upwards and the steelwork should be designed to resist this by using angles rather than flats for all tension members and by attention to the roof covering.

The external walls of a war-time factory should be regarded as simply protective screens against weather and bomb fragments. Panels and sheeting should be so designed that blast damage shall not be transmitted by them to the framing. To ensure that the sheeting shall blow in harmlessly it should be of asbestos-cement or other brittle material with anti-scatter protection by means of wire or sisal netting which may be of large mesh, securely fixed to the steel framing behind the sheeting. The use of corrugated steel sheeting is not recommended for walls, as although it will blow out harmlessly from a hit inside the building it is liable to cause considerable buckling of the steelwork under the effects of a near miss outside the building.

Load bearing brick piers are to be preferred to continuous brick load bearing walls if brick walls are to be used. The use of lightweight internal partitions to subdivide a factory should be avoided. Such partitions are particularly liable to blast damage. Substantial internal partitions can afford considerable measure of protection.

Roof covering could be :—

1. Flat roof incorporating monitor lights and giving overhead protection by a 4 inches reinforced concrete slab. Anchor the slabs to the steel framework, to withstand and uplift pressure on the roof of at least 100 lbs. per square feet. Alternatively the slabs may be linked together.

2. Sheeted Roofs—corrugated steel sheets is ideal covering. The hook holes being slightly weaker than the purlins, the sheeting will be blown off without damaging the purlins. Proprietary forms of sheeting consisting of flat or corrugated steel sheets coated with a water-proofing compounds could be used. Insulating board lining under sheeted roofs should on no account be used. Roof glazing should be entirely eliminated from new factories work being carried out solely by artificial light.

Services: In many cases cast iron and other buried pipes have been fractured by ground movement at a distance from the bomb explosion.

This danger can largely be eliminated by isolating the service pipes from the effects of ground movement. The principle should be to provide an air space between the pipe and the surrounding ground. This can be done in several ways. The pipes can be laid in ducts or in certain cases guard trenches can be provided on each side of important service pipes.

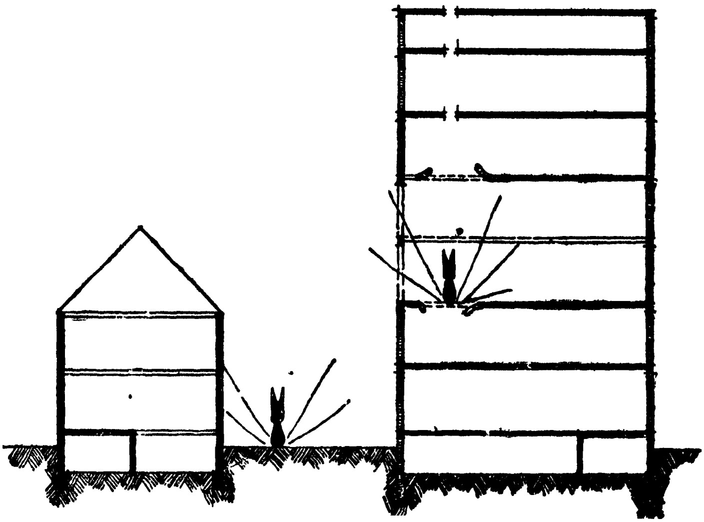
Protection of personnel: Wherever possible shelters should be in the form of covered trenches under the floor of the shop with entrances suitably traversed at frequent intervals.

Protection of plant is vital and can be provided simply. Individual machines should be protected against blast and splinters wherever possible by traverse walls, at least as high as the machine, and where practicable, by a substantial roof.[1]

Most of the principles mentioned regarding large structures apply with equal force to smaller ones. Steel or concrete frame construction may be expensive compared to their size and use. Since the probability of a direct hit is less, in detached buildings and small ones the " protective wall " type could be used. In this case the building will be constructed as a structural framework, and the external walls, which will be designed to withstand the pressure or suction of air following the explosion of a bomb outside the building, will be monolithic with the frame. It is considered essential to incorporate in the construction some form of frame which although it need not carry the building wholly in the accepted sense of the term " framed construction " should nevertheless be so designed that it will support the building in an emergency should some part of it be destroyed." But the adoption of frame construction in small buildings does not produce economy proportionate with those obtained in large tall buildings. Framing may increase the cost by about 25 per cent. and it is doubtful whether the increased resistance offered by it would be proportionate. With blast and splinter-proof walls 13½ inches thick and with the frame members so close to each other the blast force will have nearly

[1] *Vide* " Builder", 14-2-41, p. 184-85.

equal effect on the entire structure. The difference in force will not be appreciable and the cost of repairs would be equally great. As shown in the following diagram protective walls are to be preferred.

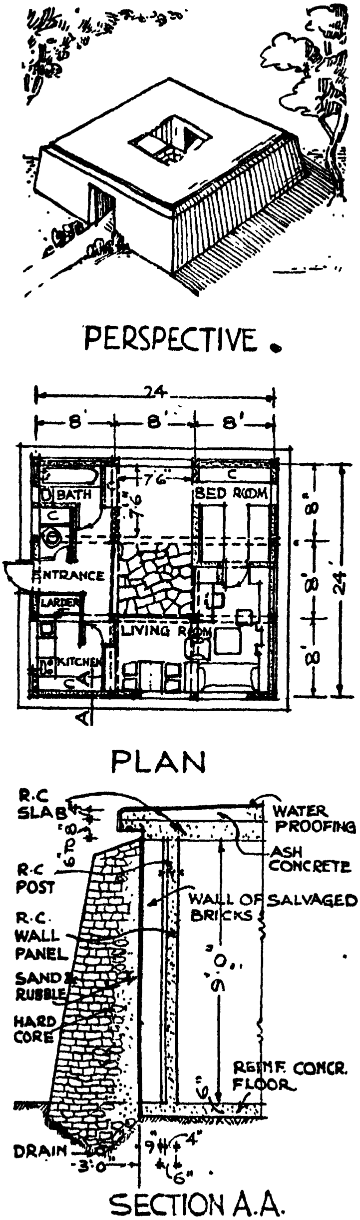


'Protective' and 'Safety Valve' Wall and Floors

The use of reinforcement in brick work to form columns in the walls are suggested to provide the necessary vertical framing but this will not cost less than reinforced concrete.

For a large residence a frame is desirable. Reinforced brickwork may be used. A subsidiary framing may also be adopted. " If horizontal reinforcement is provided in the brickwork at floor level and vertical reinforcement at intervals throughout the length of the wall, a subsidiary framing will be formed which can be designed to carry the floors and superstructure should the panels of brickwork between be destroyed." The interior walls should be similarly treated so that a beam is formed on every wall at each floor level unless a wall beam is formed in the floor construction.

The linking of reinforcement is also necessary. Throughout the work the horizontal reinforcement in the external and internal walls should be linked together wherever possible, and the vertical reinforcement in the walls should be linked to the floor construction to provide a tie to resist the suction wave from an external explosion.



A type of house designed to offer greater resistance to air raids

The wall areas between the sections which are reinforced vertically as columns can with advantage be reinforced horizontally to increase their strength, this reinforcement should however in no circumstances be linked up with the columns.

Stated summarily[1] small buildings in addition should incorporate the following features, if they should reduce their vulnerability to destruction.

1. Walls should be 13½ inches in brick and cement mortar or its equivalent.[2]

[1] *Vide* Oscar Bayne, "Structural Precautions against Air Attack". The "Builder," A.R.P. Supplement, Jan. 13, 1939, p. 11.

[2] War-time Building Bulletin No. 7 issued by the Department of Scientific and Industrial Research is particularly concerned with the building of small houses using as little iron and steel and timber as possible, being chiefly devoted to concrete. The above bulletin is also concerned with the flat roof for houses chiefly however, because it takes less material than the ordinary sloping or pitched roof.

In spite of all the research work, however, the elementary fact remains that concrete for house construction is much inferior to brick or stone, that is under the climatic conditions of Great Britain. Concrete is cold and "dead," largely because it is not porous and there seems to be no question that the ideal material is brick, a fact that has been recognised in a number of areas of the world for several thousand years past.

It may be remembered that in the last war (1914–1918) a number of houses were constructed of steel or of cast iron plates and sections, but these are also inferior to brick or stone, and largely for the same reason. ("Hindu" 10-1-1940).

2. Roofs should be 5 inches solid reinforced concrete or its equivalent.

3. Windows in some circumstances should be protected.

4. Cornices, hoods and other projections should be avoided or else be abnormally well anchored.

5. Parapets should be avoided, and open grilles, or railings used. If parapets must be used, they and their copings should be abnormally well anchored to the structures.

6. All external members liable to be dislodged or torn away by the blast of an explosion should be avoided.

7. All structural work, finished surfaces, furniture and fittings should be fire-proofed as far as possible.

In fact the two most important problems affecting small structures and residences are incendiary bomb and liquid gas. Here again we have to stress the provision of fire breaks between buildings as well as water-supply.

Building them entirely with gas-proof material is impractical as in the case of larger ones already noted. We could only facilitate decontamination, washing them down thoroughly and making air circulate freely inside; large windows are necessary. The flooring should be of concrete or like material fit for washing.

Although some precautions helpful to resist gas and incendiary bombs may go against the resisting requirements for the high explosive, for instance, large windows, the weight of reform should fall on the side of the former since, when small structures and residences are separated from large buildings, the use of high explosives is less probable.

As in the case of large structures, detached buildings with space around could stand a high explosive raid better than closely packed houses. The vibration effect would be counteracted and no more than one building would suffer for each bomb if they are spaced 50 feet apart. A compound with 25 feet of space all round would be needed to provide some garden and could be secured if residences are properly zoned and planned in convenient suburbs; when the commercial, industrial and other activities of the city are separated from them.

The Coventry city architect has designed plans for "bomb-proof" houses; 2,500 were under construction during April 1941.

The homes are two-storeyed, and have concrete roofs and ceilings and are so constructed as to reduce the effect of bomb blasts. Danger from incendiary bombs will be minimised as the bombs will not penetrate the heavy concrete roofs. Even doors will be made of asbestos concrete composition. No wood will be used.

The seven-room houses have miniature shelters, with walls 23 inches thick, built in the corner of the kitchen and also under the concrete stairways, space will be left between the walls; so "damp pockets" will be eliminated and will make heating of the buildings a comparatively simple task. A house can be built to these specifications in three months at a cost of £600.

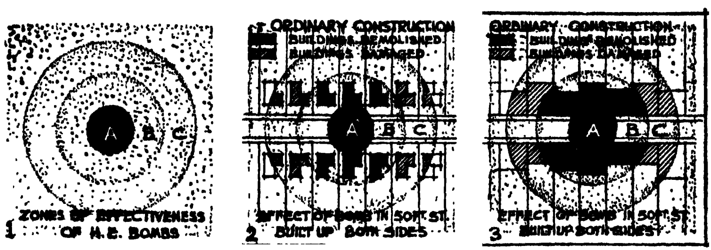


Diagram showing the value of space around buildings in reducing destruction by high explosives

According to a report in the "Manchester Guardian", Douglas Aircraft Company, manufacturers of the Boston aeroplane, are building a huge factory at Long Beach, California. The factory has been designed so as to be invisible at night from the air and to be as nearly bomb-proof as possible. Completely windowless and without skylights, the buildings will have a special internal lighting system giving a shadowless and glare-free illumination. An automatic air-conditioning plant will be installed and the air will be warmed and cooled according to the season.

The different buildings will be so spaced as to minimise the risk of damage from bombs, and petrol and oil will be stored in deep

vaults. Key departments will be duplicated underground also. Entry to and exit from the works will be through tunnels linking the establishment with roads, and the entire plant will be camouflaged.

The lay-out of the new works has been planned with a view to gaining an extremely rapid output. Every production operation will be made as simple and automatic as possible. Manual effort will be reduced by wide use of conveyor belts, power-driven monorails, overhead cranes, and jig tracks. The greatest possible use will be made of hydraulic presses. Two of these will be six-sided and will be of 2,500 tons capacity. These machines, with many others, will enable all sheet metal forming operations to be done at very high speeds.

The final assembly of aircraft, the wings and fuselages will be built on jigs mounted on tracks and moved along by power winches to a set schedule.

The Government of Madras have issued orders imposing certain requirements as to lay-out, materials and construction of buildings which may be erected, extended or altered. The object is to render these structures less vulnerable than they would otherwise be to air raids and to provide increased protection to persons using them. Under the order those responsible for the erection, extension or alteration of the structures have to apply to Government or to Chief Inspector of Factories for a ruling whether the details of this order and the provision of a schedule to it apply to the structure concerned.

The Government of Bombay have ordered that in certain specified areas, no factory providing for the employment of 200 or more workers shall be erected or extended for the purpose of carrying on any manufacturing process, or working any vital plant, except with the permission of the Government in the Home Department (Political—A.R.P.) and in accordance with such requirements as to lay-out, materials and construction as the Government may impose for the purpose of rendering the factory less vulnerable to air raids, or for the purpose of affording better protection to persons using or resorting to it.

But proper designs and plans should be evolved after great care and research to render structures less vulnerable.

The Japanese Government have decided to create an Air Defence Research Laboratory costing £50,000 for the purpose of studying building materials which will be best to withstand air attacks. The Government buildings in Tokyo are to be reconstructed on the basis of the results of the studies and experiments carried out under its auspices.

Whether it is a small or large structure it is now apparent that in addition to improvement in design and construction, open space around, ample water-supply, proper road system, open lay-out, parks and gardens are necessary to make city structures survive an air raid. Whether it is the high explosive, the incendiary or gas or a combination of all these we are again led to the problem of planning and zoning if we should save our cities from destruction.

CHAPTER V

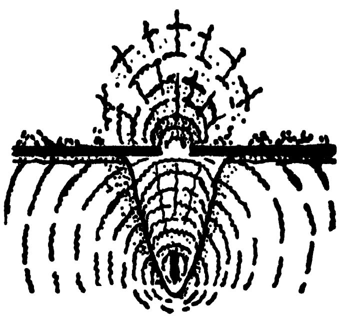
IMMUNITY TO ESSENTIAL SERVICES

CHAPTER V

IMMUNITY TO ESSENTIAL SERVICES

Vulnerability of Essential Services

Water-supply, drainage facilities, electricity, telephone and telegraph, efficient transport system, regular supply of food and food articles, as well as dairy products and vegetables are essential for the normal functioning of modern urban communities. Their destruction or dislocation will make this impossible. Unfortunately the methods of production and distribution of these essential services in modern cities render them extremely vulnerable to air raids. The high explosive bomb, the incendiary bomb and liquid poison gas either independently, or when used in combination will affect the present system. The underground system is generally adopted for water-supply and drainage and they are not laid deep. They are shattered by bombs as recent happenings in England show, and precautions are being taken to prevent the consequences. Lengthy channels connect cities to the sources of supply of water which is either a large tank or a river. The large filtration plants could also be destroyed or poisoned.[1]



High explosive bomb with delayed fuse exploding in a street

[1] The Metropolitan Water Board of London deals directly with a population of about 7,000,000 with on the average a daily supply, winter and summer, of approximately 301,000,000 gallons per 24 hours which necessitates the use of nearly 9,000 miles of mains. Incidentally this supply does not cover the whole of what is known as Greater London, which approximately has a population of about 8,500,000.

The largest reservoir in the world is the Queen Mary in the Thames Valley, which cost over £2,000,000. This has a storage capacity of 6,750,000,000 gallons of water, representing a water surface of 723 acres, while the retaining wall is about 4 miles round.

Calcutta is supplied by a huge overhead tank. The vulnerability of the water-supply system of such towns needs no emphasis.

Electric mains are also laid underground but less deeper, electric power-houses are generally overground. Telephone wires are overhead and telephone exchanges are similarly situated. Railway stations, docks, harbours and aerodromes are not merely overground but in or close to congested quarters or residences. The railway sometimes traverse through cities and in many industrial centres serves as the means of transport for large numbers. Narrow streets rendered increasingly inadequate by uncontrolled growth of towns form the distributive system defective also from the ventilation point of view.

Markets and food storage centres are generally located in crowded residential and commercial areas, and cow sheds and stables are found all over. Dairy products are largely produced within the urban area and transport animals are kept within its limits.

Even in times of peace some of these have been found inadequate and when the stress is greater in times of war they are bound to fail and their destruction by weapons of air attack could easily break the resistance of the inhabitants. Water-supply is inadequate to meet the needs of peace in many urban centres in India and the road system is getting unbearable with the lateral and vertical expansion of cities. Roads that cannot take a holiday crowd could rarely cope with the demands of evacuation and the needs of fire-fighting and decontamination squads. And when bomb craters cover the roads they would be practically useless.

Two branch lines of the central underground system were ordered to be closed at Berlin owing to damage caused during one night's raid by the R.A.F. It was reported that the entire underground power system of Berlin was put out of order.

After a heavy raid in July 1941, most of the manhole covers over the telephone and electric power cables in Ludgate Circus were "blown out. Gas mains had caught fire somewhere else in Fleet Street and minor or secondary explosions had been caused. No gas, no water, no electricity, and no lift and no telephone. Same story of hard going to get in from their homes, of no sleep through the night, of incendiary and high explosive bombs."[1]

[1] London Correspondent, The "Hindu," 22-7-41.

During the German raids on Belgrade the electricity station and water-pipes were smashed by bombs so that the city was deprived of light and water.

A heavy German bomb made a big crater alongside a railway line in Poland. A Polish armoured train which was carrying retreating troops was wrecked by this damage.

Reports of widespread damage in Berlin due to R.A.F. raids have been received in authoritative quarters from reliable neutral sources. Charlottenburg went without gas for two days, according to a reliable report. Dislocation of the city's railway traffic increased by the damage to underground—now the most popular means of transport. One attack destroyed many vehicles in the city's main tram and bus depot.

All communiciations were dislocated and traffic was further interrupted by raids on railway sidings at Potsdamer and Anhlater stations by the R.A.F. Damage seriously affected the transport system and one traveller from Berlin for the Rhineland spent three days instead of twelve hours on the journey. Much changing was necessary and travellers had often to walk some distance from one train to the next. Transport on waterways, was also dislocated. The Miteland Canal was interrupted for five days and on the Dortmund Ems Canal, the east wall north of the old aqueduct has been broken.

Gas and water-mains have been broken and fires broke at a number of points in English coastal towns by Nazi bombs.

In the West End of London in September 1940, a bomb damaged a street and a subway. A crater affected the water-main near a large hotel where guests were removed from the underground shelter to the ground floor in case the water percolated through to refuge.

Underground Telephone Cables in London were damaged by a heavy bomb. London Port Office Engineers worked at the bottom of a bomb crater to restore the lines in February, 1941.

The Rumanian oil pipe-lines near Pleosti—the centre of oilfields —have been damaged by bombs.

The famous Dortmund Ems Canal, a vital junction in the German canal system, is unrecognisable and practically useless as a result of R.A.F. bombing.

High explosive bombs can easily affect transport facilities by hitting and destroying the transport units, buses and trams and by creating bomb craters in the middle of roads. Instances of both have happened in London.

During a severe blitz Oxford Street, centre of London's West End shopping district, was hit by a high explosive bomb and a deep crater was created. An emergency bridge had to be erected for buses and pedestrians to pass over.

Transport difficulties have been aggravated by bombing in London and suburban areas.

During the R.A.F. raids in Africa, an aircraft of a Rhodesian squadron raided stores and dumps in Africa. A direct hit completely wrecked a railway station building at Adarti, while goods trucks on the sidings and a group of huts near the station were also badly damaged.

In Midlands a train was machine-gunned and a few persons were slightly injured. In the Home Counties a number of persons were killed and seriously injured by bombs and machine-gun bullets. The dining car of the train was damaged but the bombs dropped did no damage.

Trams have been hit during daylight raids on London. Once three people were killed. A woman, a driver and a conductor died as the result of this direct hit from a Nazi fighter-bomber. Windows and woodwork were blown out, seats were shattered and buried in the roadway. Women ripped their clothes to provide temporary bandages for the injured. Many were cut by flying glass. Windows in buses were also shattered.

During a raid on London in September 1941 damage to utility undertakings caused gas to be cut off over a wide area. Thousands of East London workers found normal trains not operating in the morning.

A high explosive bomb, dropped by a German raider during a daylight raid in London on 25-10-1940 exploded in a street crowded

with traffic. It fell on a tram which was crushed and badly damaged four others. All the five trams, some of which were filled with workers, were drawn up close together near traffic lights. A number of other people have been seriously injured. Buses in the same street had their windows shattered by the blast and the passers-by injured by the flying fragments.

A bomb which fell on a main London thoroughfare seriously damaged two omnibuses and killed and seriously injured a number of persons during Nazi activity over London. There were, however, some fatal injuries among railway passengers when a train was hit by debris.

A blast wrecked a crowded bus. It overturned and caught fire. Most of the passengers were killed while passers-by, people waiting at a bus stop and sheltering in doorways, added to the death-roll.

A caravan bus was wrecked when South-West London was attacked on 16-8-1940. Its coach work was perforated by machine-gun bullets.

The blast of a bursting bomb on 8-9-1940 flung a stationary bus against a building, pinning the radiator to the window sills of an upper floor.

Of the London Passenger Transport Board servants, 116 were killed, 322 were injured by enemy action while engaged in the performance of their ordinary duties. The death and injury to persons employed in transport system should also be reckoned in addition to the destruction and damage which may be caused to vehicles and the tracks. It is believed that casualties would have been heavier than the above if the *Luftwaffe* had concentrated their attention on London and suburban transport systems.

It is officially stated that 101 persons were killed in a train which was hit during a Japanese air bombardment of the French-owned railway between Yunnan and Haiphong in French Indo-China in February, 1940. Five of the killed were of French nationality, who include two women and a child and sixteen other were native railway employees. The remaining eighty were Asiatic passengers in addition, 120 people were wounded.

During the raid on the Suez Canal damage was done to telephone communications in that area.

Experience in Poland and Finland, Norway and Holland bring to light that these are made the objectives of attack. Electric power-houses, aerodromes, railways, bridges and moving passenger vehicles are attacked. Precautions have been taken in several European countries to prevent dislocation. The Civil Defence Act of Great Britain compels the owners of public utility services to camouflage their premises and even a grant is made by the Exchequer. According to Clause 39 :

" There may be paid out of moneys provided by Parliament towards approved expenses of public utility undertakers in taking measures, whether before or after the passing of this Act, to secure the due functioning of their undertaking in the event of hostile attack, grants not exceeding one-half of those expenses."

They are further subjected to obscuration of light in the interest of safety. Clause 45 insists that along with factory premises or mines, these public utility undertakings may be compelled " to take over or complete such measures as may be specified in the notice to secure that the factory premises, mine or as the case may be, any of the premises of the undertaker, can be made less readily recognisable by air-craft in the event of hostile attack." The Government grants half the expenditure incurred by the party who is compelled and if they do not comply they are liable to a heavy fine and conviction.

In France the height of buildings is regulated to prevent demolished buildings blocking the road and hindering movement of traffic when it is most needed. The Town Planning regulations of Poland, according to an order issued in May 1939, prescribe: "roads and streets must be straight and should run in the direction of prevailing wind, leaving at least 60 yards between the fronts of buildings on main thoroughfares."

In India, soon after the outbreak of hostilities in Europe, police guards were placed near aerodromes, electric power-houses, water-supply sources, etc.

In U. P. an Act has been passed called the U. P. Water-Supply and Fire Services (A.R.P.) Act, 1941, with a view to making better provision for the creation and maintenance of water-supply and fire services for the protection of the general public from the dangers of air attacks.

The Punjab Government have decided to provide structural air raid precautions at a number of hydro-electric sub-stations in the Punjab at an estimated cost of Rs. 1,74,000.

Measures to ensure that the labour population in Calcutta and the industrial area remain at their posts in the event of enemy air raid were considered at a Conference held at Calcutta in August, 1941. Government felt that labourers must be made to realise that during an air raid, or in anticipation of an air attack, they should not leave their places of employment.

Col. A. J. Reeve, Director of Training and Operations, Government of India, suggested a complete overhaul of the water-supply service of Karachi.

That these precautions cannot save destruction will be evident from the experiences already recounted. Attempts are being made to prevent the flooding of underground systems by the damage done by high explosives. The effort made in London is noteworthy. The London Passenger Transport Service has taken steps to prevent flooding in the tubes in case of severe damage by air raids. They consist of the installation of massive steel doors or gates at stations where the railways pass under the Thames and also in the immediate neighbourhood of water-main or sewers which might probably be burst by bombs. By closing these new steel gates flooding of the underground system may be prevented. Special sector gates have been placed between the foot of the excavators and the platforms on the northern line at Charing Cross which if necessary will close the passages leading from the district station above. At Charing Cross there are six of these sector gates each weighing 4½ tons. During an air raid they could be raised or lowered in two minutes by electric motor with a push button control. In addition there is emergency hand gear for raising the gates.[1]

When the war started these openings now controlled by the steel gates were completely plugged up with concrete as a precaution, the one at Charing Cross weighing 25 tons. Such costly precautions would become inevitable if underground systems are to be adopted. In residential zones for Indian cities an underground system is undesirable both by its initial cost and by its risk and the expensiveness of protection.

[1] The "Hindu".

To underground systems if they are not very deep gas bombs may prove doubly dangerous when they combine high explosives with them and when they are equipped with a delayed action fuse, they may damage service mains under the roads. The water, gas, and electricity mains may be contaminated by gas and may also be damaged by explosions. The gas may burn and water may carry contamination down the sewers; electric cables may absorb the liquid. They might have to be cut off before decontamination work could begin and after decontaminating the crater, metal pipes carrying gas and water may have to be cut out and replaced. Drain pipes of concrete or stone have to be treated with bleach paste. Electric cables may absorb the liquid in their bitumen coating. The copper strands may get corroded. If the rubber coating is heavily contaminated that section of the cable must be replaced. Underground telephone wires if encased in stoneware ducts would have to be washed with paraffin or petrol.

Overhead telephone wires are unlikely to be heavily contaminated unless they are blown down by an explosion but telephone exchanges would be rendered unfit for use by a gas spray or a combined high explosive bomb. Gas can similarly dislocate the transport system by contaminating the vehicles. If the contamination has been heavy it is possible that corrosion will develop later.

Several methods have been suggested to prevent dislocation. Removal of plants and power-houses is advocated. But a spasmodic removal is inconvenient and costly and sometimes impossible. Now that the threat of air raids prevail for fairly long periods this measure cannot help. A permanent removal outside the city limits would appear desirable but cannot eliminate the danger unless the distributive system is rendered bomb-proof. Keeping more than one source is suggested on the principle that if one is destroyed others would function. This is uneconomic and impossible for drainage systems and the like. An alternative source to be harnessed during emergency might be admirable for a railway station but not for water-supply etc.

Although the problem is simpler in our country the preceding chapters would show that protective measures are uneconomic, otherwise unreliable. Public utility services liable to dislocation when one part of the organisation is affected are unsuitable from the

point of view of air defence. The desirable system should be one which will make dislocation by throwing a few bombs impossible.

Water-Supply and Drainage: Residential Zones

That this is possible is now disclosed by researches in Public Health, Nutrition, Sociology, Town Planning and other sciences directly affecting human welfare. A proper combination could give birth to a system immune to dislocation.

The needs and finances of the residential and non-residential zones of a city differ fundamentally and in approaching the solution, the two aspects need to be viewed separately. Regarding residential zones the supply of water could be immuned by tube wells, one or more for every house or groups of houses. This would provide protected water-supply immune to gas attack and dependable during emergency. Wells properly constructed and protected would also serve and help the needs of fire fighting and decontamination. The problem of drainage can be solved if adequate open space is allotted for every residence. A kitchen garden would provide necessary green vegetables and would prevent underground drains and cess pits. The plants will use the water of the household. "Sanitation is purely an agricultural question and the country where every cottage has or should have its patch of garden there ought to be no difficulty."[1] This observation made by a well-known medical authority has great significance in planning for air defence. The problem of sanitation will be automatically solved by this method.

The need for sufficient space around is also stressed by sociologists who emphasise the need for a correct balance between men, occupations and land for ensuring optimum welfare for humanity. The neighbourhood unit idea is rapidly gaining ground in U. S. A. and space around the house, garden and vegetation are deemed essential, to give the correct perspective to life and to make man healthy. Town Planning principles restrict the number of houses per acre to twelve and individual town planners consider six or nine better. A system of suburbs where six to nine or twelve families live per acre, water-supply and drainage could be made immune to air raid. Where more density is inevitable Dr. Poore's idea could be applied by combining groups of families in residential estates or

[1] Vivian Poore: Essays in Rural Hygiene.

blocks of houses each self-sufficient for water-supply and drainage. Where even this is not possible small colonies could be made self-sufficient by locating them in proper surroundings. Three to five hundred families, it is considered offer optimum unit for ensuring social intercourse, personal contact, and community interest, after years of research in American Universities. Recent opinion considers 750 houses as the minimum number for a self-sufficient community and was advocated at the International Federation for Housing and Town Planning at its 16th Congress at Mexico by those responsible for the Green belt town now being built by the Federal Government.[1]

The optimum size for groups of families have yet to be discovered for India but 750 families may not be unsuitable to form residential estates, that could be rendered air raid proof regarding essential services. The average village in India contains from 200 to 500 families and these were autonomous self-governing and self-sufficient units over which India's prosperity rested for centuries. Indian Town Planning insists on tanks, open spaces, water-courses and fields around as essential parts of the village plan. Indian villages in the early Buddhist age more or less conformed to the requirements for resistance dictated by the needs of air defence. A cluster of houses with streets laid to harness light and breeze to help ventilation with tanks and gardens, surrounded by pasturage, can defy raiders better and it is not impossible to form a city with such residential surroundings.

Water-Supply and Drainage: Non-residential Zones

Non-residential areas of large cities create a problem owing to lack of space and the necessity for multi-storeyed structures. Open drains and independent systems are not possible. But the occupiers could pay for a bomb-proof system. In fact a deep underground system has been suggested by experts in the West.

Drainage, water-supply, gas, electric power, light and telephone should be grouped together and run below the roads and made safe from bombing by running in tube subways constructed of reinforced concrete, and kept about 20 feet below the surface. The road surface should be formed of heavy reinforced concrete to serve as a detonating slab. "This road surface would never require to be cut

[1] J. T. P. I., Oct., 1938, p. 412.

up for alterations and renewals of the service conduits, as they could be freely got at from the armoured tubeway formed for this purpose."[1]

Power Stations

Regarding power stations, the bombing aeroplanes are already causing considerable reform. The dangers of " all-the-eggs-in-one-basket " policy are becoming obvious. It is a dangerous policy to erect new gigantic central power stations of say 500,000–1,000,000 K.W. capacity which might be put out of action by a single concentrated attack from air-craft. The sensible policy is to have half a dozen widely scattered stations inter-connected of the same total capacity.

Already power stations have been designed and in some cases constructed with heavy concrete walls, up to 2 feet thick, with no windows to reduce the dangers from splinters and blast from a considerable distance. A new development is the construction of special completely bomb-proof emergency power stations which it will be impossible to put out of action, say by burrowing into a hillside or by construction underground with an enormously thick concrete and earth roof. For these emergency stations not only are diesel and petrol engines being employed but also super-pressure forced circulation boilers and steam turbines. Manufacturers on the Continent are already producing bomb-proof power station plants, suitable also for ordinary peak loads.[2]

Lighting could be made independent for each unit and in emergency the dwelling could be lighted by mineral or vegetable oil. Overhead electric cables connecting one suburb to the other or any hydro-electric station could be suitably laid and camouflaged by vegetation abundant in the tropics.

The protection of utilities so as to permit continuation of service under air attacks is of paramount importance in maintaining industry and production.

Utility organizations in regions where there may be danger of attack should make plans for the following:

[1] W. Braxton Sinclair, " Town Planning in Relation to A.R.P."

[2] For a short description of a plant of 9,400 K.W. comprising a " Velox " forced circulation super pressure steam generator and condensing steam turbine plant supplied by Brown Broveri & Co., Ltd., of Baden, Switzerland, see *Hindu* 5th May, 1940.

1. Continuation of electrical service and measures to be taken to minimize the effect of bombing.
2. Measures of defence in the construction of new power installations to minimize the effects of bombing.

1. CONTINUATION OF SERVICE AND PROTECTION OF EXISTING FACILITIES. One of the best methods of providing continuation of service is that of having all sources of power interconnected so that even complete destruction of an important plant would result in the minimum interruption to the power supply. All vital control apparatus and conductors should be duplicated in so far as is practical and should be so arranged that in the event of destruction of one unit, its duplicate could be put immediately into service. Another protective measure, where feasible, is to have replacement units and parts of equipment strategically located and designed for rapid transportation to replace a partially destroyed element.

High-tension lines are not easily destroyed or broken down by aerial bombing. Few direct hits can be made by enemy planes unless they have the most favourable conditions for attack and fly very low and along the transmission right-of-way. Even in such cases, direct hits resulting in the destruction of the steel towers seldom occur. Towers are sometimes damaged by fragments of exploding bombs, but in most cases this damage is not sufficient to interrupt the power supply. Multiple transmission lines having different routings or widely separated rights-of-way, and selective relay protection for the different circuits, will reduce the interruption of power service to a minimum.

2. NEW CONSTRUCTION. New buildings of permanent construction which house important equipment or operations should be of framed, fire-resistant construction, with walls of sufficient thickness to resist fragments and roofs at least heavy enough to stop light incendiary bombs.

Power-plant machinery and other vital equipment should be given protection against fragments. Provision should be made for adequate fire-fighting equipment, and for concrete fire walls or barriers to prevent such spread of fire as might happen when oil-filled transformers and switches are used.

The construction of outdoor stations should be arranged so that sectionalization or cutting-off of damaged sections may be done

quickly and service restored over undamaged sections. A wider separation of the more vulnerable units, such as transformers, will serve to decrease the liability and extent of damage. Outdoor substations preferably should be of latticed angle-iron construction, and the transformers and oil switches may be protected by walls of concrete, brick, or sand-bags, as previously described.

Penstocks, gates, etc., which are particularly likely to be damaged, should have adequate control equipment and valves to localize the damage.

Outside flow line of equipment, including penstocks, oil piping, gas pipes, and other vital appurtenances of hydro-electric plants should be placed underground or in strongly constructed concrete ducts or tunnels, wherever this is feasible and financially practical.

Many of the points covered under the protection of buildings and utilities are applicable to industrial plants. Steam-boilers, machinery, essential water and gas mains, switch-boards, and electrical cables should receive special attention. Besides causing disruption of operations, the destruction of supply pipes by bombs might involve flooding or explosion.

Communications must be maintained for emergency service. Duplication of lines and location of telephones in shelter and first-aid stations are necessary for adequate control.

Wooden boxes filled with sand are an excellent substitute to sand bags.

Reserve supplies of water in static tanks or other reservoirs should be provided.

Auxiliary power plants should be provided and maintained in working condition. Duplication of power and communication lines, switch-boards, and other utilities is desirable.[1]

Road System and Transport Facilities

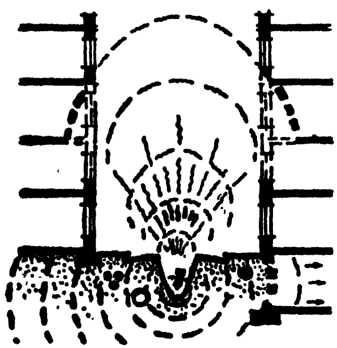
A strong impervious road surface is essential to prevent contamination and facilitate decontamination: A gas spray on concrete paths or paving stones need no treatment other than

[1] *Vide* "The American City," July 1941, pp. 87-103.

hosing. But if they have been splashed with the liquid they must be left to weather in addition. In a congested centre elaborate methods of decontamination are essential and the road surface should as far as possible resist absorption. In warm or mild weather as in India it is unlikely that any danger will persist by fine spray after one hour. If the streets can be kept clear for an hour after the spray has fallen there will be little danger.

But traffic must be closed at least for three hours and constant hosing at intervals of one hour and immediate attention will be required for gross spray and decontamination. Pavement stones or slabs or concrete do absorb the liquid and porous joints surrounding stone setts will do similarly. "If the stone or concrete is hot, as may be the case in sunny weather or in a tropical climate, a good deal of the liquid will be vaporised in a short time and the remainder though quickly absorbed will be given off again later as vapour. This means that the danger from vapour in the streets will be great, though the problem of decontamination will be less."[1]

This consideration indicates that roads must be so laid as to facilitate the breeze blowing through, to clear away the vapour. The need for wide roads will now become apparent. This factor should also determine the location of different zones of a city. Cities in India should be prepared to meet heavy vapour from mustard gas. Tar and bitumen dissolve blister gas especially in warm weather and should not be used for road surfaces. Tarred macadam, bituminous and asphalt surfaces are equally unsuitable, for decontaminating them is particularly difficult if immediate action is not possible. Heating up the road surface is necessary if the liquid has been completely absorbed but this will damage the road surface. Water-bound macadam surface may not absorb much blister gas but its rough surface renders hosing down with water less effective. Hard brushing will damage the surface and be wasteful.



The dangers of a hard surface in narrow streets of the walls and foundation of buildings

[1] A.R.P.M. 3 "Organisation of Decontamination Services."

Methods of Decontamination for Road Surfaces

Surface	Method of Treatment
Treatment for Fine Spray. All surfaces	In busy thoroughfares hose down with water if this can be done within 30 minutes In all other circumstances leave to weather.
Treatment for Gross spray and outer zone of bomb contamination. All surfaces	Hose down with water as quickly as possible for 10 minutes. Repeat treatment. Pavements for immediate use can be brushed with thin cream of bleaching powder and water.
Treatment for Gross contamination round bomb craters. Stone setts	Cream of bleaching powder and water. Brush well into joints. Leave in contact for 15 minutes Finally hose down with water.
Stone paving and concrete	Hose with water for 10 minutes. Sprinkle with dry bleaching powder. Brush well into surface for 5 minutes. Also treat gutters. Finally hose down with water.
Wood paving	Hose with water for 15 minutes. If jointing material is soft, cover with sand. (If heavy liquid splashes visible, treat with bleaching powder and sand before hosing : brush well over surface and leave in contact for 1 or 2 hours).
Tarred macadam, bitumen or asphalt	Hose with water for 15 minutes. Use dry bleaching powder treatment for grossly contaminated areas. In certain cases road heating machines may be used.
Water-bound macadam	When possible leave to weather. If treatment essential, sprinkle with bleaching powder and leave for 10 minutes. Then hose gently with water for 10 minutes.
Natural earth, grass, etc.	Cover with 2 to 3 inches of fresh earth and leave to weather. If contamination very gross and near to occupied premises, add top layer of earth and bleaching powder 3 to 1.

Vide A.R.P H.4 Appendix B.

A hard surface no doubt increases the danger of blast and splinters to adjacent structures but sufficiently wide roads would reduce this danger. They would further minimise the danger of vibration of traffic and bomb explosion and is also essential to prevent traffic congestion.

These considerations need not be literally applied to open country and residential zones for weathering might be depended upon to do the task of decontamination. As the Home Office handbook recognises elaborate methods "may be entirely unnecessary and wasteful on an open high way."

The road system therefore requires great attention and care. Its lay-out, its surface, its width, etc., need special attention. It also forms the physical basis of the system of transport and to satisfy the requirements of air defence the road system should: (1) facilitate quick movement, (2) protect underground systems if any, (3) increase the resistance to vibration of buildings, (4) reduce vulnerability to gas contamination, (5) help ventilation by securing sunlight and breeze and (6) provide fire breaks.

These are essential if the road system should offer resistance to air raids and make transport possible. But these are equally necessary to make them useful in times of peace. The military requirements coincide in the main with civil needs of the population, so that the ideal military road system of communication would well serve civil needs in peace time.[1] A number of important planning questions converge around the type of road plan adopted equally vital to military and civil needs. The military demands require an excellent service of straight broad roads, free of risk from falling brick debris, linking up the many defensive positions, such positions to be distributed at required intervals, generally through the city

[1]Refugees cumbering the roads were a constant cause of disorganisation during the fighting in France ; and often seriously hampered the operations of their own side. Instructions now issued by the Home Office to householders on what to do in case of invasion lay it down as a first principle that no one should move until ordered to do so. Columns of refugees on the roads often hampered the allied Defence. The Germans deliberately exploited the refugee problem by Machine-gun attacks.

Mr. Churchill's message in May 1941 continued saying that the same applies to the people inland if any considerable number of parachutists or airborne troops land in their neighbourhood, and emphasised that above all they must not cumber the roads.

area and would have a spread of about 10 to 15 acres, each to give an ample field of vision.

Civil requirements dictate that roads should form a network to divide up property into business units and the main arteries to be adequate for traffic and provided with diagonal connections with subsidiary centres, which should occur about every square mile of city area.

A road system that would fulfil all these various requirements is a combination of the chess-board plan with a simple system of spider web plan to subsidiary centres which would give the best road results, and at the same time provide an elastic basis for the open spaces of greens and parks; thus the dark squares of the chess-board would indicate the varying disposition and area of the open spaces or defence positions according to the density required. This type of plan would give excellent opportunities for the town lay-out with open squares, small parks, gardens, athletic grounds, and at the same time would produce a very effective part of the camouflage of the disposition of city zones and buildings when viewed from the air. Large groups of trees and parks in cities and towns have the effect of breaking up the forms and making identification of targets more difficult from the air.[1]

In addition to the lay-out of roads, the transport units that convey passengers and goods must be capable of surviving air attacks. Railway trains are vulnerable to bombs and machine-gun fire and should be discouraged within urban areas. If economic conditions warrant goods may be conveyed by a deep underground line to the heart of the city from a station situated in the outskirts. Bomb craters would hamper the movement of tramcars and they must be discarded. Although instances of machine-gunning moving buses have come to light small mobile units have better chances of escape and are preferable in the interest of security.

Cleansing station for vehicles or vehicle decontamination depots also form part of this scheme. Yards large enough to accommodate contaminated vehicles must be situated in localities where the risk of vapour from them will not cause danger or inconvenience. Provision for ample water-supply to these depots must be made. " The process of decontamination would involve copious

[1] *Vide* Braxten Sinclair.

use of water and the actual decontamination stands on which the vehicles would be washed should therefore have a hose water-supply (a high pressure of water is unnecessary), and ample drains for carrying away the contaminated water." Since washing road surfaces also require copious water, tanks and reservoirs suitably placed on the road system form part of a system of transport and communication which might be considered reasonably safe.

Food Supply

The production and supply of vegetables, milk and dairy products as well as food grains and other essential articles also need protection. Modern urban communities depend for their protective food on cattle housed within city zones. Markets, oilman stores, restaurants and boarding houses are situated in the most crowded parts of cities. Their contents are liable to be affected by poison gas and cattle and other animals are seriously injured and disabled particularly by mustard gas.

It is suggested that edible articles should be packed with gas-proof materials and they must be kept covered as far as possible. The Home Office insists that attention must be bestowed during transport and distribution and advises to make " all store-houses as gas-proof as is practicable." The protection of food-stuffs against poison gas is the subject of a special booklet. Air-tight bottles or sealed tins offer complete protection against all forms of gas. Air-tight glass or earthenware jars offer similar protection if covered with glass, metal or bakelite. Sealed wooden barrels provide complete protection against vapour and moderate amount of liquid gas. For prepared edibles however, waxed cartons and cellulose transparent films give good protection against gas and liquid.[1]

The problem of protecting food supply thus covers the location, design and protection of hotels and markets, etc., the preservation of pasturage and fodder for cattle and their housing, and the provision of cultivation in close proximity to supply as far as possible food grains and food articles.

Restaurants and hotels should be housed in gas-proof structures or in buildings which could be converted into gas-proof ones. Their design and construction should be such as to render contamination difficult, and washing down easy. Their location should also be

[1]The Protection of Food-stuffs against poison gas.

helpful to defy contamination. Uncovered food-stuff should not be displayed in windows or on counters or shelves. The period of warning before an air raid is likely to be short and would not give sufficient time to pack away large quantity of food which was displayed without protection. This precaution against gas is equally welcome in times of peace for health and sanitation.

The storage of food grains in large quantities in the suburbs and the surrounding agricultural belt also needs attention. As a result of air attack near Hamburg docks, three silos containing about 10,000 tons of wheat have been completely destroyed. Terraced houses which could be rendered gas-proof are preferable. Where this is not possible, as during the harvest, they must be covered by large tarpaulins and left in the field. Strong thatched stacks of grain could also be similarly protected. Grain silos, not very tall, granaries convertible into air raid shelters in the surrounding areas would help the storing of grain not merely for protection but for better prices.

Not merely protection of food, but its production and supply to citizens must be ensured. Careful observation and experience has now proved that production must be as far as possible close to the centres of consumption ; preferably in an adequate green belt of pasture and agriculture encircling a city. Where such a system does not exist acute hardship has resulted.

Since 1914 the amount of arable land under crops in Great Britain, had actually decreased by four and a half million acres. For every thousand acres of cultivated land in the last war there were 1,195 human beings to be fed and the figure now was 1,424. Moreover, there had been general decline in the fertility of the British soil, taking the country as a whole.

Between the outbreak of the last war and this war the production of fodder and root crops for live-stock had fallen by no less than one-third. As Mr. Lloyd George has pointed out in this grave hour, the life of the nation depended on agriculture. Germany was beaten in spite of her great victories in the last war because she had no food. She neglected her agriculture partly before and almost entirely during the war. She flung her men into the battle-field as if the only field that mattered was that of battle and not the fields behind the battle-front.

Citizens in England have been advised to eat less and conserve food as a precautionary measure. Girls are being taught how to make the best of the rationed foods.

Thousands of English housewives are, for the first time in their lives, making use of horse meat in the family meals. They are mostly North-country and Midlands housewives, and the horse meat is contained in a meat roll, or galantine, which is being manufactured in ever-increasing quantities in London, writes a *Sunday Dispatch* reporter.

Even His Holiness the Pope is now on rations; 3¼ oz. of meat and 10½ oz. of bread daily. Three and a half ounces of butter has been allowed weekly and 17½ oz. of sugar monthly.

The grounds at the All-England Lawn Tennis Club at Wimbledon are ploughed up for war-time food production.

The need for "Ploughing for Victory" has been emphasized even in India. Mr. Marsh, Adviser, U. P., pointed out that those who live by cultivation and could not participate directly in war could help victory by making two blades grow where one grew before.

The "Grow More Food" campaign has been taken up by the Government of India also. But, as 'The Hindu' has pointed out, the instruction has been mechanically passed on to the officers of the Agricultural Department. Every villager is accustomed to grow something of his own. It requires but organisation, propaganda and small help to him to stimulate an increase in the production and use of vegetables. A proper approach would make each household self-sufficient for its green vegetables. Open space surrounding the residence thus becomes inevitable.

The question of maintaining an adequate supply of protective foods leads to the problem of protecting animals during air raids, and ensuring them with fodder and food. Horses and bullocks used for transport purposes need protection.[1] But they could be treated along with the milch cattle. Sheep and goat should be

[1]A.R.P.H.12 Air Raid Precautions for animals.

reared to make meat available. Fortunately pets, dogs and birds do not give us a great a problem as they do in England.[1]

" Animals, like human beings, will be exposed to the risks of air attack in a modern war, and everything possible to protect them should be done. Around docks, railway goods depots and industrial centres there may be considerable number of transport and other animals and such areas are likely to be attacked. On the other hand it is unlikely that the destruction of farm animals would be considered as a primary objective of hostile attack owing to their normal dispersal, and if such stock were affected it would probably be merely incidental, but the effects would be no less serious no that account."

Evacuation is not possible in the case of transport animals, or food animals, awaiting slaughter. To some extent milch cows could be evacuated but this will lead to inconvenience. No satisfactory animal gas mask has been yet produced and gas and bomb-proof stables in city zones are not practicable. Although fodder exposed to the true gases, aresenical smoke or the vapour of blister gas will not remain dangerous, if aired for a few hours, they may become unpalatable.

The ideal remedy is to remove them outside the city zone and the residential areas and to house them in pasturages surrounding the city. Ample water-supply, open air and sunlight necessary to help resisting and recovering from a gas attack are possible only in this green belt. The general advice given regarding A.R.P. for animals and their treatment tend to show that protection is possible if live-stock are kept in the outskirts of cities with plenty of open space, with ample water for washing and drinking and plenty of sunshine and open to make them recover quickly from contamina-

[1] Even the scare of possible air raids in Bengal have affected the import of milch cattle into Calcutta. While in normal times more than 2,000 milch cattle used to be imported into Calcutta every month there was no import of such cattle into the city during the whole of January 1942. There is also a dearth of goats and sheep in the city.

Reports indicate that the Government demands for them cannot be met as " goat keepers do not visit the city now with their flocks." The price of meat has consequently gone up by stages from 8 annas to 12 annas a seer in the course of the month of January.

The advisability of using the meat of animals such as goats, cows and sheep killed in air raids, for human consumption is now engaging the attention of the Government of Bengal.

tion. Even in non-urban areas it is considered advisable as far as possible to keep large animals such as horses, milch cows, etc., in the fields rather than in stables. The remedies suggested to recover from gas attacks prove this need. For mustard gas affection of the skin the animal should be hosed down with water for half an hour. Affected eyes should be freely irrigated with water and if it is a respiratory tract plenty of fresh air and rest are essential. Lewisite gas injuries need washing with soap and water or water alone within 20 minutes after contamination. For phosgene gas attack, first essential is to remove the animal from the dangerous atmosphere. The animals should be kept in the open air, rugs and bandages being put on for warmth.

All these require plenty of fresh air and expansive areas. Non-persistent gases can do little injury if cattle are housed and grazed in a green belt surrounding the town. Persistent gases cannot be made to cover the entire belt and even if one part is endangered grazing could be had in the other. Dairies are best situated in the wide areas surrounding the city. The high explosive and the incendiary bombs cannot dislocate milk supply.

Vegetable gardens in the adjoining areas would ensure steady supply and if the food grains needed for the city are raised in the land adjoining this green belt the problem of 'grow your own food' during war will not arise. A nation composed of cities and villages whose food supply is assured from the surrounding area can resist aggression successfully. It will also help to achieve the correct balance between occupations, industry and food supply and population and thereby a stable foundation to civilisation.

The decentralisation of food and the consumer's food industries and the establishment of a nation-wide system of small and medium plants to utilise only local raw materials is ordered in a decree published on January 12, 1941. It is signed by M. Stalin and M. Molotov, Prime Minister and Commissar for Foreign Affairs.

Under the existing system of central planning, the decree points out, local resources have been neglected, with the result that there has been an inadequate supply of man's essential commodities.

The mobilisation of all local resources and the utilisation of by-products will also reduce the burden on transport.

Research

The main difficulty however, is the absence of data to determine the various standards and quantities to form the ideal patterns and compositions.[1] Whether it is the residential unit and the kitchen garden, the quantity of food and population, the number of cattle and the grazing area adequate data are lacking. The size of the group of domestic dwellings in residential suburbs that would be the optimum unit; the size of the plot for each residence; the proportion for the built-up area to the open surrounding; their location with reference to the air raid shelter as well as to open parks and vegetation; the arrangement of different groups of families according to their occupation and economic condition; the optimum size for the urban community and the ideal pattern of spacial arrangement; the proportion of population to business, administration, occupation and work, etc., all these must be discovered to plan a successful scheme and to evolve the ideal pattern. This alone can make it possible for the normal functioning of the society during air raid and make dislocation by destroying essential services well nigh impossible. Elaborate precautions now being taken in the West are too expensive to our country and a peaceful agricultural civilisation cannot afford to be extravagant for emergencies. Self-sufficient and self-reliant units capable of making their parts work independently during emergency would form the ideal basis for the urban community particularly in this country where money is limited but land and nature are abundant.

[1]Admirably constituted Government research stations and departments already exist in our country. There are, besides, other bodies organised for research in universities and under the authority of other independent institutions. We should also reckon the potentially vast research resources that could be mobilised by the captains of industry. Co-ordination, the fundamental requisite, is however needed.

CHAPTER VI

ESSENTIALS OF AIR DEFENCE

CHAPTER VI

ESSENTIALS OF AIR DEFENCE

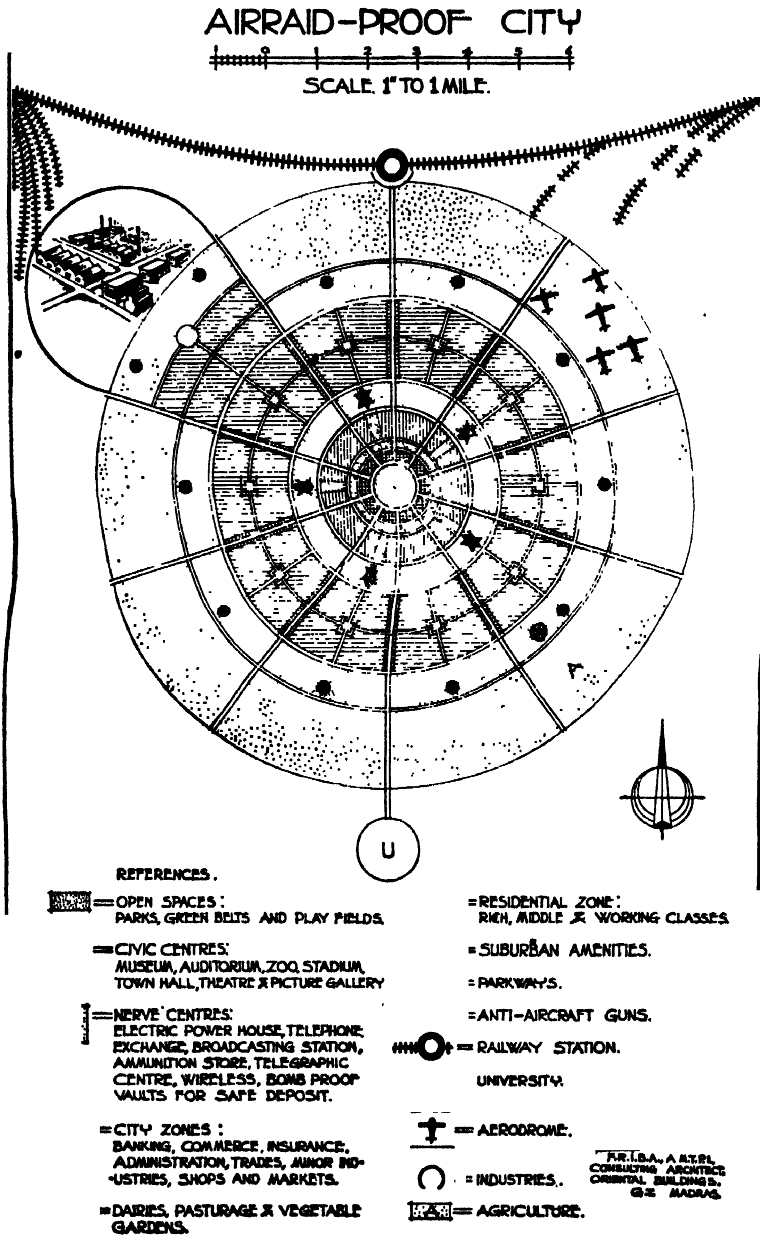
It would be evident from the previous chapters that the essentials of air defence are, bomb-proof shelters for all the people, structures that would resist and recover from air raids and services the supply of which is immune to dislocation. To these should also be added a suitable contingent, anti-aircraft guns, and ground defences, balloon barrages, to prevent low-flying attacks, as well as fighter planes. Without such active defence the task of the raider would be enormously simplified and passive defence measures would prove inadequate. A defenceless city will fall a prey to a handful of bombers and machine-gun fire as did Steinkjer in April 1940. They are needed to force the raiders to attack the targets from a great distance and in great hurry—the two factors which render destruction difficult. If anti-aircraft defences are not successful and effective now it is largely due to the defective lay-out and development of modern cities which impose too heavy a burden upon them. A properly planned city will be a helpful combination, minimise their difficulty and enhance their effectiveness.

These four fundamental requirements would assure to people reasonable security from the air menace. Where these four features are combined to produce the optimum effect, the community housed there, would defy the most carefully engineered air attack. This would produce a degree of resistance that would make air raids uneconomic and not worthwhile and would undermine the enemy's incentive to adopt this course as his method of aggression.

Cities for Air Raid Protection

What is the ideal combination and how will this pattern of a city look like? Local conditions and requirements would affect this a great deal but the disposition of the different parts of the civic organism would be more or less as shown in the diagram.

Around a large central park would be located the civic buildings, surrounded by a green belt of parks and vegetation separating the


AIRRAID-PROOF CITY
0 1 2 3 4 5 6
SCALE 1" TO 1 MILE.
U
REFERENCES.
=OPEN SPACES: PARKS, GREEN BELTS AND PLAY FIELDS.
=CIVIC CENTRES: MUSEUM, AUDITORIUM, ZOO, STADIUM, TOWN HALL, THEATRE & PICTURE GALLERY
=NERVE CENTRES: ELECTRIC POWER HOUSE, TELEPHONE EXCHANGE, BROADCASTING STATION, AMMUNITION STORE, TELEGRAPHIC CENTRE, WIRELESS, BOMB PROOF VAULTS FOR SAFE DEPOSIT.
=CITY ZONES: BANKING, COMMERCE, INSURANCE, ADMINISTRATION, TRADES, MINOR IND-USTRIES, SHOPS AND MARKETS.
=DAIRIES, PASTURAGE & VEGETABLE GARDENS.
=RESIDENTIAL ZONE: RICH, MIDDLE & WORKING CLASSES.
=SUBURBAN AMENITIES.
=PARKWAYS.
=ANTI-AIRCRAFT GUNS.
=RAILWAY STATION.
UNIVERSITY.
=AERODROME.
=INDUSTRIES.
=AGRICULTURE.
F.R.I.B.A., A.M.T.P.I.,
CONSULTING ARCHITECT,
ORIENTAL BUILDINGS,
G.T. MADRAS.

city zones, business, commerce, administration, etc. A green reserve of 500 to 1,000 yards would separate this area from the surrounding residential suburbs, and prevent the bombs aimed at City Zones from harming them. These suburbs would be self-contained, in matters of drainage and water-supply and amenities could be provided suitably. Preferably with a population of 10,000 each, the suburbs will have suitable areas for the residences of working class, the middle class and rich class. Pasturage and vegetable gardens, will surround the suburbs and help to improve urban nutrition. The University, however, will be taken out of the busy city zones, as well as the factory and heavy industry. Encircling this will be an agricultural belt to avoid "digging for victory" in times of war. The city's requirement in cereals and pulses and other food grains would be obtained from this area. Around this would be village units separated from each other by green belts. They would be rendered attractive enough to draw townsfolk to them, whenever they can.

An efficient and economic transport system would help this scheme and connect the city with other important centres of the nation. The road system within would combine the spider web plan and the rectangular scheme to ensure easy and quick movement of people and vehicles in normal and in war conditions and provide sufficient visibility and ventilation and other requirements of civic welfare.

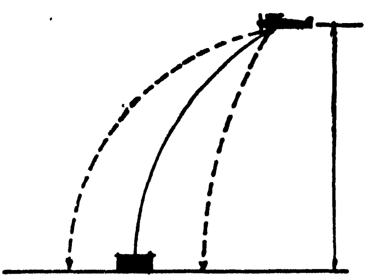
The railway would provide easy access both to the industrial zone and the city and the emergency line will come into use if the main line is destroyed. The aerodrome is so located that the anti-aircraft guns would help the defence of the railway and the industry in addition. In times of war fighter planes and ground defences would dot the encircling pasturage. Playgrounds, wide open spaces, tanks and reservoirs in the green belts and built-up areas will help to defy gas attack and the spread of fire. All zones will possess air raid shelters which would ensure safety to people in emergency and serve as community centres and garages in times of peace. Buildings would be dispersed and carefully located to reduce the chances of direct hits. The design and construction would be improved and they would render, gas and incendiary bombs ineffective and considerably reduce the destructive effects of the high explosive. Although air raids cannot be made impossible they would be rendered uneconomic and inadvisable.

Now it will be clear that the fundamental needs of air defence are zoning and planning and the dispersal of men and buildings. These simple and wholesome principles are not merely effective in times of war but are essential for the welfare of mankind in times of peace. When these principles are properly applied we obtain urban communities invulnerable to air raids. The essential features of such urban communities, in other words, the essentials of air defence are, green belts, parks, vegetation ; a rational road system ; wells, tanks and reservoirs ; carefully laid out residential estates and non-residential zones ; industries and universities, drawn out; nerve centres carefully placed, and anti-aircraft devices adequately arranged.

Green Belts

Green belts, parks, playgrounds, and pasturage are needed for separating the different units of the city as well as for encircling it and fulfilling " a military need to enclose and limit the city boundaries and to provide dual encircling road communications with ample scope for the provision of aerodromes, anti-aircraft gun positions, searchlight stations, etc. within the belt area." The parks, playgrounds and open spaces within would help to separate the different aspects of the city and ensure safe distances from likely targets to residential areas. Bombing is a very inaccurate job particularly when bombers are in hurry and thus arises the need for separating residences from important objectives.

As General Winkleman[1] pointed out while explaining why he abandoned resistance to German invaders, " in a densely populated country like ours, it is difficult to distinguish between military and civilian objectives. Rotterdam has undergone a dire fate which a total war brings to towns and cities. Utrecht and other towns would have undergone the same fate . . . we were unable to defend the country against the invader." Green



The probable range of variation in bombing a target

[1] "Hindu", 14th May, 1940.

belts and parks are eminently suitable and desirable to help zoning a city.

The Official German Wireless broadcast a warning in Flemish to the Belgian population that to attempt to leave their towns and villages at present was tantamount to suicide.

It stated that it was impossible for bombers to distinguish between civilian and military objectives on the roads. The people were told to stay at home, and go to shelters during air raids.

Half a mile width is considered to be the minimum at a radius of five to fifteen miles from the centre by some. In India a greater width may be allowed to be used as pasturage and an inner belt about half a mile in width is preferable to separate the city zones from the residential areas. In times of peace these would serve a very useful purpose. In the inner green belt could be situated schools, community centres, health clinics, etc. as well as small industries such as laundries, to cater to the needs of the people. The outer belt would help to provide the city with vegetables and dairy products and protective foods. It is now realised that towns of to-morrow should provide for an optimum diet and "food" must be fresh and the citizen should draw the greater part of his protective food from his neighbourhood.[1] The surrounding region should therefore be planned to give the maximum efficiency to an association of recreation and agricultural needs. The Barlow Commission on the Geographical Distribution of the Industrial Population of Great Britain after exhaustive enquiries observe : "it is important to have high cultivation near large centres of population" and agriculture should be considered regionally, and the best possible use should be made of the agricultural land in the region.[2] To secure a proper local balance between rural produce and urban needs, building schemes or industries must be prevented from encroaching on rich agricultural land necessary for fruits and vegetables for city consumption.

The medical profession claim the importance of a close relationship between agriculture and men for healthy living. Healthy soil

[1] "Requirements of To-morrow Town," by A. A. Rowse, Principal of Planning and Research for National Development, London. *See* J.T.P.I.

[2] *Vide* extracts from the Royal Commission on the Geographical Distribution of Industrial Population Report, J.T.P.I., March-April, 1940, pp. 69–85.

12

and healthy people are inter-related. A better agriculture in close connection with a neighbouring city will do far more towards abolishing the disease of tuberculosis than any of well known methods adopted under the guidance of sanatorium experts. An anti-tuberculosis campaign based on agriculture would do untold good in our country.

A belt of agricultural land around the city will help to solve the drainage problem. Urban dietary, the purification of sewage and urban waste, a belt of agricultural land around the city are inter-related.

A wide green belt is further necessary to maintain the distinction between town and country. Wide country belts should be preserved around all cities and towns and the density of urban areas limited sufficiently to permit of the building of houses with gardens for all who desire them, and also to permit of the provision of playing fields on some accepted standard at reasonable distances from all houses.

The problem of food supply in times of war also necessitates agriculture surrounding the town and immunity to animals is possible only if they are maintained outside cities. The "Grow Your Own Food" campaign should serve as the eye-opener and a green belt of pastures and fields must surround a city both for air security as well as human welfare.

As many large trees as possible should be preserved in these green belts and parks and pasturage and their preservation encouraged to maintain the correct balance between the animal and the vegetable kingdom. They are essential to mitigate the severity of tropical heat and to help camouflaging likely targets. Experts predict that the present rate of consumption of wood would lead to a world timber famine in thirty years. Wars with less planting and more cutting may bring the famine appreciably nearer.[1]

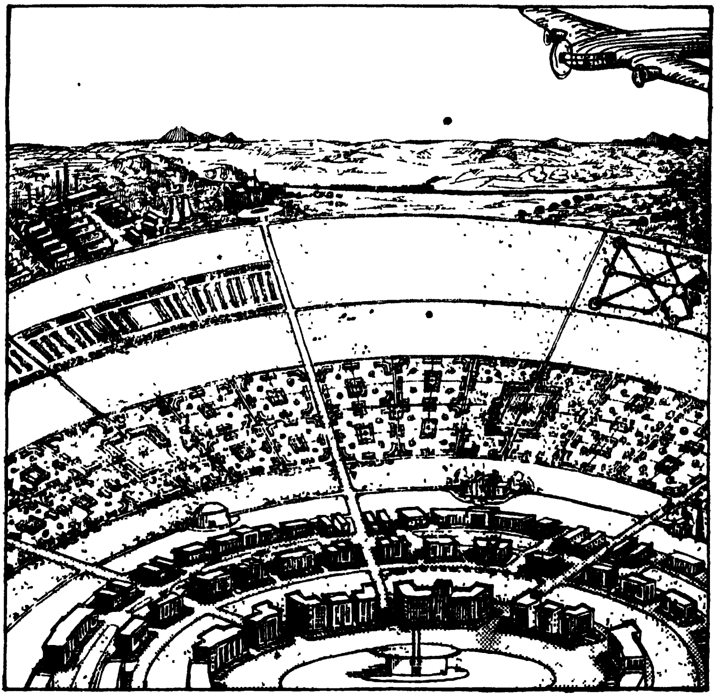
The world is just becoming conscious of the folly of neglecting forestry. Forestry is being carried out in many countries. The "New Deal" in the U. S. A. has kept thousands of men permanently at work planting trees. Britain formulated a forestry policy after the Great War. Even a thick wood adjoining the agricultural

[1] *Vide* D. G. Johnston, "Disappearing Forests," the *Hindu*, 5th May, 1940.

belt around urban communities is desirable while trees and parks and pastures are essential.

Rational Road System

The next requirement is a sound road system. Here again requirements of defence coincide in the main with civil needs of the



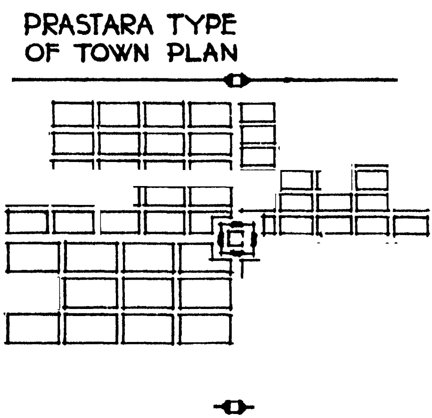
Perspective view of a city which would resist air attacks

population so that the ideal military road system of communication would well serve civil needs in peace time. A number of important planning questions converge around the type of road plan adopted, equally vital to military and civil needs. The military demands require an excellent service of straight broad roads, free of risk from falling debris, linking up the many defensive positions, such positions to be distributed at required intervals, generally through the city area and would have a spread of about 10 to 15 acres each, to give an ample field of vision. Civil requirements dictate that roads

should form a network to divide up property into business units and the main arteries to be adequate for traffic and provided with diagonal connections with subsidiary centres, which should occur about every square mile of city area.

In Britain non-essential traffic has been prohibited during emergency by an order of Government. The Minister for Transport has made an order empowering the Regional Commissioners to prohibit the use of any class of vehicle in their areas. The primary object is to prevent roads urgently required for military movements being blocked by non-essential traffic.

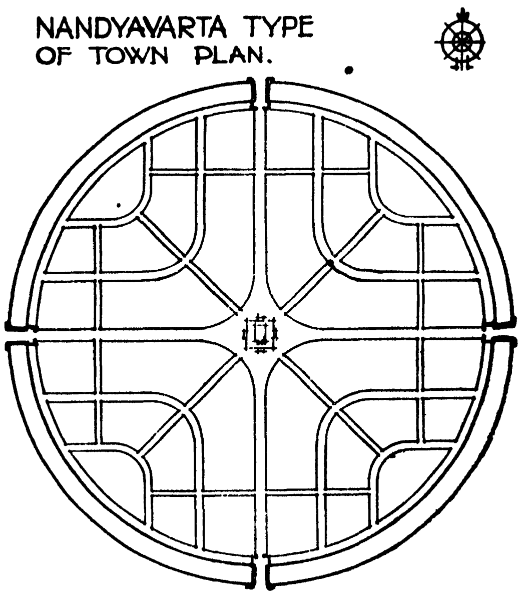
A road system that would fulfil all these various requirements is a suitable combination of the chess-board and spider web pattern. This would give the best road results and at the same time provide an elastic basis for the open spaces, of greens and parks. This type of plan would give excellent opportunities for the town lay-out with open squares, parks, gardens, playing fields and at the same time would produce a very effective part of the camouflage of the disposition of city zones and buildings when viewed from the air.



The road system recommended by ancient Indian Town Planners for the Prastara type of towns

For residential areas the road system advocated by the ancient Hindu Town Planners and practised for centuries by the exponents of the Vastu Vidya, seems desirable. Even in countries where the rectangular system proved highly disadvantageous, such a system

is now considered desirable for residential areas. "Internal service roads," observes Clarence Perry of the Russel Sage Foundation, "should, in fact, be aligned deliberately in such a manner as to discourage all but essential domestic traffic from using them."[1] The road system should further divide the surrounding land into areas suitable for residential zones and in a manner permitting their expansion as shown in the diagram.



The road system recommended by ancient Indian Town Planners for the Nandyavarta type of towns

The internal road system would in addition consist of boulevards and parkways not merely along the green belts but also through them reaching the University and Railway Station. Externally arterial roads will connect the city with other important centres of the country, and suitable subsidiary roads would provide access from these to the minor centres.

[1] Clarence Perry, "Housing for the Machine Age." Review in J.T.P.I. Oct., 1939, p. 371.

Tanks, Wells and Ponds

Tanks, ponds, wells and bathing pools suitably located and dispersed all over form the third requirement. Copious supply of water required to deal with fire and gas attack cannot be had by underground systems liable to destruction by bombs. Even otherwise, they may not cope with the demand. The strain can be met with, only by the former means and cisterns with water are being placed even in London streets. Even medical authorities on A.R.P. have proclaimed this need for European cities and they would be welcome features to tropical towns, in peace and in war.

Central Park and City Zones

A large central park about half a mile in diameter around which the civic buildings, stately edifices, art gallery, museums, temples and the like may find location, is another essential especially to provide chances of survival to monumental structures. This location would help the enemy who cares to spare them for they would be away from probable targets. Anti-aircraft guns and balloon barrages could be located here to protect the buildings around, which for obvious reason cannot be made to conform to the principle enunciated for resistance in Chapter IV. All architecture cannot be sacrificed to air defence and only this method can assure chances of survival.

The next requirement is properly located city zones, commerce, administration, trade, banking, insurance, etc. preferably situated around the central area, separated from each other by parks and open spaces and gardens and roads. These activities need proximity and should be kept close to each other but separation is needed to localise the destructive consequences of raids. Drainage and water-mains must be laid deep underground and roads must be wide to check the spread of fire and vibration effect on buildings. The buildings would, of course, be framed structures not more than six-storeys located around garages which would serve as bomb-proof shelters in emergency.

Townships and Villages

Of supreme importance is the residential estate planned in the form of townships and villages, self-sufficient and self-reliant in matters of drainage and water-supply and amenities ; these to be

removed from the city zones by a green belt at least half a mile in width; with community centres convertible into air raid shelters during emergency, forming the foci of each group of residences. Tanks, parks, playgrounds would intersperse residences. The dwellings must be one or two-storeyed, fire resisting detached buildings, one for each family with sufficient open space around so as to render the incendiary bomb ineffective, gas concentration impracticable and the use of the high explosive bomb not worthwhile. A group of thousand persons should have an air raid shelter and the size of each unit about 10,000 population.

Such a scheme is considered essential to avoid the breakdown of the social and utility services and to check the force " beating down the will to live " produced in large crowded cities like London, Glasgow, Birmingham, Manchester and a dozen other cities of Great Britain. It is feared that unless this is done urban communities will disintegrate.

The peace-time value of such schemes is considered to be immense. In fact sociologists emphasise that such regrouping is needed to prevent the disintegration of urban communities. The model " To-morrow Town " prepared by the School of Planning and National Development recently exhibited in London indicates that in the interest of tranquillity and healthful domestic life, "the towns must be planned to contain a series of communities isolated from each by green belts and woodlands which are the natural projection of agriculture into urban life since live-stock should graze these areas. In these belts should be situated the schools, community centres, health clinics, and local administration and public buildings, which serve the community. The foci of each group of residences should be community centres, and the town should be a system of villages co-ordinated into an urban region of approximately 30 square miles, of which the built-up area should occupy a little over three. Each community centre should focus about two thousand families of all classes, and sub-community centres should concentrate the life of an " acquaintance group," of about 2 to 3 hundred persons. A " communal drawing-room " should form the centre of a " friendship group " of about four or five families. This is the number which Sociologists and Psychologists tell us constitutes the intimate circle in which friendship can really grow."

Main shopping and recreation centres would be provided for each group preferably in the middle to facilitate transport and proximity to consumers but their numbers should be restricted to avoid overcompetition. The figures for proportioning of shops to population are sometimes given as 1 to 30 for middle class families of Great Britain, based upon their needs gathered from Family Budget Enquiries and similar investigation will be required before the proportion could be fixed for this country.

In any neighbourhood, the houses people live in, the schools they use, shops, cinemas, public houses, etc., make up a unit which might contain ten thousand people, or only one or two thousand. The community centre should be located within a well-defined neighbourhood unit, and as near as possible to the focal point of that unit. The planning of the building would depend, first, on the people who were to use it, and secondly on the activities to take place inside. There was a case for the segregation of the younger people from the adults, because of their noisier activities ; but the opinion is gaining ground that adults and juveniles should be together.[1]

Regarding the density and type of dwelling, the Joint Committee of the Medical Colleges of Great Britain recommends (in its evidence to the Royal Commission on the Geographical Distribution of the Industrial Population) "not more than twelve houses should be erected per acre of building site ; each family should have a house with a garden ; and it is suggested that the scheme of the garden city is a model towards which the location of industry should work."

The City of Coventry Housing Scheme recently planned, supports this view. It consists of some 2,000 houses on various sites and marks a definite development in English planning and constructional standards. Access space is reduced to a minimum, and the spans have been largely standardised and reduced to economical limits to suit the concrete floors and roofs. Walls on the ground and first floors coincide so that there is no eccentric load on the concrete first floor, all loads being taken directly and simply to the ground. The larder walls have been thickened and the size of the larder increased to form an air raid shelter which will take three tier bunks, and additional ventilation is also provided. The plans

[1] Mrs. Flora Stephenson ; *Vide* " The Builder ", May 2, 1941, p. 148.

are in progress and photographs illustrate a standard three-bedroom, wide frontage parlour type of house.[1]

A recent survey of the problem of housing has revealed that " the single family dwelling is almost essential for the lower income groups." A single-storeyed residence to accommodate one family is preferable ; a large one carefully designed wherein a few families are to be housed might be tolerated. For richer folk two or three storeys is permissible if larger space around is possible. More than this is not advisable for residential purposes.

Open spaces, playgrounds and parks are absolutely essential if some of the vital human needs must be met within the suburb efficiently and if recreational centres should be provided for small children within a quarter of a mile from their homes. The Barlow Commission emphasises that in laying out of new towns proper foresight should be exercised to secure adequate open space for the recreational needs of the population. Consideration should also be given to the question of the best possible distribution of the recreational areas ; " for instance, five parks or areas of 10 acres each, well distributed may be of much greater utility from the point of view of recreation than a single park or area of 50 acres."

The four elements—work, leisure, housing, and transport—are completely inter-dependent and form the basis of the problem of housing.

Housing proposals should be based on a social structure built up of the following units :—(1) Residential unit of 1,000 people, of which the nursery school and the every-day life of the people form the basis; (2) neighbourhood unit of 6,000 which gave the right number of children in the elementary school age groups (480 from five to ten years and 480 from ten to fifteen) for an efficient school structure; (3) the borough or town unit of 50,000 people—a size which make a full measure of social life an economic possibility ; (4) the city district or small city, comprising 12 such borough units grouped together and (5) the city—ten such districts as in (4) forming the city or metropolis of 10,00,000—the figure considered the maximum even for the population of London.

According to Major Maxwell Fry, such a city should have playing fields for schools, 16,000 acres ; for factories and offices

[1] "Builder ", March 21, 1941, p. 297.

30,000; open play space near the home, 15,000; and private gardens allotments and rest areas, 15,000—a total of 76,000 acres. The proposals included the reservation of a ten-mile week-end zone of purely rural country around London and the reorganisation of holiday resorts on sea coasts within fifty miles of London.

All sidings and marshalling yards should be planned at the extremities of the main artery and outside the circular connecting railway, thus freeing large central areas for parkways and redevelopment.[1]

With children up to 14 years of age it is vital that their recreation grounds should be near their homes and the best solution of this difficulty is so far as possible to supply this need in connection with their suburbs. School playgrounds cannot suffice, for proximity is essential. Children use streets as playgrounds and this is a common feature in many urban areas. Playgrounds for smaller children are a park economy and incidentally will help to obtain the correct regional balance of man.

In the residential zone or sectors formed by the green belt and the main roads provision is to be made for the poor, the middle and the rich classes. A composite character is necessary to avoid the dull uniformity that would result from one class of people and from the deadening monotony with which the region would suffer. But a mixed group is possible, only when the entire lay-out is cleverly done and the architecture is properly controlled. Slum areas could be rebuilt in such a manner that people of higher income groups may be perfectly happy in living in such neighbourhoods because the attractive window vistas, the parks and tidy streets will be such as to give the locality a definite tone.

A sound environment is essential for the welfare of the people and such a suburb would make possible this vital requirement. Here it will be possible to view ' man ' as part of the region and plan his home, his garden, his leisure and his work accordingly. The importance of this consideration will be realised by the fact that a new council has been formed and conference called on problems of social environment in February 1941 in London.[2] Believing that the welfare of the people depends on sound environment for the

[1] *Vide* " Builder ", April 18, 1941, p. 392.

[2] Report upon the Conference on Problems of Social Environment and the War, held in the R.I.B.A.; the " Builder ", 9-2-1940, p. 162.

individual, " resolved that a Council should be established with the immediate object to promote through research groups and by other means, the planning of social environment on a national scale and to make widely known the need for such planning."

Opinion differs as to the maximum size of the suburb. The estimates made in the United States and by Principal Rowse have been given. To India the criteria selected by Clarence Perry would be suitable. " A residential unit development should provide housing for that population for which one elementary school is ordinarily available within rather less than that distance from any home. One-tenth of this area should be allocated to open space and no through traffic road should traverse the area, although such roads may conveniently bound it."[1]

The plans adopted by the Slough Borough Council recently for a residential estate covering an area of 125 acres of land support this idea ; the residences are so laid out that the main road does not pass through them. Only pedestrian traffic is allowed within the built-up area; the open lay-out, siting of the church and school and playground, the provision of trees and shrubs all follow the needs of A.R.P.

With regard to air raid shelters, the principle of providing a strengthened ground floor room, preferably the kitchen, in each house is better than the erection of outside shelters in the back gardens and should prove less costly in the long run if provision is made in the building contracts.[2]

Such residential suburbs are essential to save children from the horrors of air bombardment and would obviate the need for special plans for children, because modern cities are very unsuitable. A project for centralising in Portugal all international efforts to protect children from the consequences of aerial warfare is to be made officially by the Portuguese Government to all belligerent powers. The plan was unofficially put forward recently in the newspaper *Diaro Denoticias*, urging the establishment of " safety cities " in all countries at war where children would be guaranteed freedom from bombardment. " Let us centralise in Portugal and co-ordinate the magnificent work of the International Red Cross

[1] Clarence Perry, Vide *ante*.

[2] *Vide* J.T.P.I., Nov.-Dec. 1940; p. 30.

units, wrote the newspaper, "This generation, representing the Europe of to-morrow, cannot be held responsible for the bloody conflict now proceeding in Europe. It is a question of saving from dread and death and inevitable physical debility thousands of children—English, German, French, Italian, Belgian, Dutch, Norwegian and Greek without distinction."

Pasture and Agriculture

The next requirement is a wide belt of pasturage preferably surrounding the residential areas to feed and house cattle and live-stock, catering for the dietary, transport, and other needs of the city. This would eliminate the dangers of mixing cattle shed and residences together and the difficulty of protecting animals in air raids. Aerodromes and anti-aircraft positions would lie in this area and check the raiders in advance and the anti-aircraft shells would do less damage to the city.

Nerve Centres

Carefully located railway stations, aerodromes, nerve centres, etc., are also needed for air defence. Regarding the location of docks, railway terminii, factories and other vital points one school of thought with the idea of reducing vulnerability would advocate their splitting up into a large number of small groups in different areas in order to reduce the risk of complete disablement. This is desirable to some extent but the loss of economic operations and coherent and well organised defence are disadvantageous. To meet this difficulty it is suggested " to make for halfway provision and provide only dual groupings for vital zones, which has become a common rule of precaution in many spheres tutored by A.R.P." This is not possible for all the items above mentioned. Electric power houses might follow this principle. The railway line is best removed outside the city and connected by an efficient bus system.[1] To the average Indian city it is advantageous to have the station as shown in page 174. For emergency use an alternative line must be provided at a safe distance from the normal one. When the usual line is destroyed the other might be used and temporary platforms and stations could be improvised.[2]

[1] Provision could be made in the planning of our future cities for the carrying of goods to feed markets and parcel service and refuse disposal by underground system suitably connected to the main railway system particularly in city zones.

[2] Proximity of railways is dangerous: for instance five hundred houses were destroyed at one stroke when a munitions train was blown up by a British bomber at Le Havre.

Aerodromes are large and easily recognisable from the air and constitute a very important objective for the raider. They must be equipped with anti-aircraft devices. Lest anti-aircraft shell fragments should injure men and building, aerodromes must be located at a safe distance from the residential and business areas. This is also necessary to ensure civic comfort in times of peace. Air-craft noise is especially distracting to those who live in the neighbourhood of aerodromes where people are learning to fly and where a great deal of low flying necessarily takes place. The Goral Committee which studied this problem therefore consider it advisable that Town Planning Schemes should in their very earliest stage make provision for the preservation of aerodrome sites by suitable zoning in order that difficulties that may be met with in the past may not be perpetuated.[1] They also feel that care should be taken to ensure that the future use of lands adjoining intended aerodromes (Service or Civil) should be so restricted as to prevent its development for such building purposes as would render impracticable the enlargement of aerodromes should need arise and obviate possible complaints of nuisance. A suggestion has been made in America to prevent concentration of air-craft which is very vulnerable. Flight strips properly camouflaged are advised near highways at suitable distances from cities and hangars. Services and repair facilities would not be there and they would be used for landing and for taking off. Locating them in the pasturage surrounding the town would meet these requirements and when sited as shown, will facilitate access to the city and the railway, and also economise the need for anti-aircraft devices by making possible for lesser number of units to safeguard both the railway station, the aerodrome and factory suburbs.

Nerve centres not easily destroyed are essential and their location should facilitate effective camouflaging. The post and telegraph office, the telephone exchange, the wireless station, electric power-houses, etc., as also bomb-proof safe deposit vaults for the use of the public and bomb-proof chambers for preserving government and public records, manuscripts, and rare books which cannot be replaced when once destroyed and bomb-proof ammunition stores must be situated in green belts. Minor industries that cater

[1] Report of the Goral Committee on the Control of Flying, J.T.P.I., p. 212.

to the needs of the citizens would also make use of this land if required. Government offices and administrative departments which need not be in the busy zones could also be located here. The trees and vegetation and parks would make identification of targets more difficult and when creepers and plants are grown and allowed to cover these structures, in the fashion of the village homes covered by plants which provide vegetables for the inmates, an effective camouflage would become possible at very little expense.

Separation of Industry

The factory and the heavy industry should be located outside the city zone. They are particularly liable to attack and even unsuccessful attempts would amply reward the bombers by the casual destruction. Proximity to residences and city zones is conversely disadvantageous to them for this same reason. Separation is dictated by the requirements of air defence as also splitting very large units into smaller ones. Diversification of industries is also essential to infuse strength into civic communities and to prevent the destruction of one city from affecting many others. Defence must influence the choice of location and this applies even to consumer goods industries, whose labour supply, raw materials and markets would be very much affected by the large scale evacuation of target areas planned in the event of war. Vulnerability of transport and utility services would also be another serious consideration. The Report of the Regional Development and Location of Industry of the P.E.P. points out:

" In order to make important industrial plants less attractive to the bomb, it is necessary to consider the possibilities not only of local defence but of spacing out buildings on the site, particularly where the risks of fire or explosion are high and of moving production out of the most vulnerable areas." They conclude " that dispersal of works away from target areas is needed, as well as dispersal of sections of works on the site ; that new locations should as far as possible be chosen away from obvious landmarks, such as bends of rivers ; that the more fragile type of factory construction should be avoided ; that duplicate means of transport and raw material supplies should be found and brought into regular use ; and that large stocks should be maintained at the points of consumption or procession." [1]

[1] The Report by the Regional Development and Location of Industry Groups of the P.E.P; J.T.P.I., April 1939, p. 202.

Diversification of production and occupation is necessary both for resistance as well as to obtain a balanced regional development. While it is impracticable to assure that every town should be feasible to secure considerable diversification in every region a large region composed almost exclusively of cotton towns or coal towns or a city specialising in soaps or steel etc., has been shown to be highly precarious. The objective of policy should be the attainment of maximum earning capacity with minimum risks and liabilities in the long run over a wide area, instead of the pursuit of maximum earning capacity in peak years in towns of narrow areas with high risks and with liabilities left uncovered.

Requirements of peace also dictate that industries must be removed, dispersed and located outside the towns. This is further necessary to facilitate the location of residences for the workers at satisfactory distances from them. Separation will avoid traffic congestion, fatigue to workers as well as the noise and smoke problem to citizens. It is now felt that there is no evidence to show that noise associated with industrial life is diminishing and it is felt that population can be protected in a large measure from its effect by enlightened town planning and decentralisation and that the same is true with regard to smoke. Statistics submitted to the Barlow Commission appear not only to establish a correlation between smoke pollution of the atmosphere and the excess mortality but to show that though the harmful effects of the smoke-producing heavy or textile industries upon health have diminished in England during the last twenty years, those effects are still very potent.

That smoke is dangerous to Air defence has been pointed out by the Executive Committee of the National Smoke Abatement Society.[1]

Under certain atmospheric conditions the palls that form over the towns and drifts across country, would make it more difficult for hostile air-craft to recognise specific objectives, but whatever the loss of visibility might be it would to at least to an equal extent be a hindrance and source of danger to defending aeroplanes and would create difficulties for the ground defence.

Palls of smoke, forming clouds, or " smudges " of haze on the horizon would frequently make it easier to hostile air-craft to detect the presence of distant towns and industrial works, while the long

[1] *Vide* J.I.M.Cy.E., Vol. LXVII, No. 4, p. xxi.

plumes of smoke frequently seen, even in country districts would quickly betray the presence of isolated factories and works that might otherwise have remained unnoticed.

From time immemorial smoke has been used as a guide, or on the other hand, has betrayed the position of those who wished to be concealed.

Therefore, apart from other cogent reasons for reducing smoke, which do not become less important because of the war, measures for the prevention of any smoke that could possibly assist aerial attack should be effectively undertaken.

Smoke abatement is important not only on its own account, but also because it is of direct assistance to measures for coal conservation and fuel economy that are to-day more essential than ever.

Industrial undertakings using solid fuel in boiler plants and for other purposes should, in their own monetary interests as well as in the interests of the nation, secure the minimum of smoke emission as one factor, in the economical running of their plant.

War conditions render more difficult the always complex problem of the abatement of domestic smoke.

Domestic smoke abatement is desirable not only for its own sake, but because it is one factor in the movement towards placing the use of coal on a higher level of economic and scientific utilisation. The demand for smoke abatement stimulates, and at the same time is made practicable by the use of smokeless coals, the smokeless derivatives of coal, and to a partial extent, improved methods for the use of bituminous coal.

Although restrictions upon domestic fuel consumption have for the present been discontinued, it may be necessary for them to be introduced again in the future.

The National Smoke Abatement Society therefore urges the most careful consideration being given to the formulation of a national fuel policy, both on general grounds, and because its own objective of the prevention of atmospheric pollution will best be accomplished by the more rational use of our fuel resources and the elimination of the gross wastages of which smoke is one costly indication.

Smoke is, indeed, a by-product of the technologically primitive phase of our industrial civilisation from which we have not yet emerged.

The social and economic consequences of smoke, serious though they remain, are inevitably subordinated to the infinitely graver social and economic consequences of modern war. It would, therefore, be inappropriate to seek to give them undue prominence at the present time. The heavy financial cost, the toll upon health and amenity, and the general waste of human labour and effort, nevertheless remain serious and useless burdens upon the community. These burdens are in no way nullified by, but unnecessarily add to, the heavier burdens that now have to be borne.

The abatement of the smoke nuisance should therefore be persisted in, and not lost sight of among the more immediate and for the time being more urgent of our war efforts.

The position is thus summarised : " a policy of decentralisation or dispersal of industry from overcrowded areas is definitely to be recommended on strategical grounds : of this there can be no question, and such a policy coincides with and reinforces the general proposals on similar lines already shown to be desirable in connection with the social and economic disadvantages of concentrations."[1]

The location shown for industry in page 174, simply indicates the need for separation and suitable sites could be selected according to the prevailing wind and site conditions.[2] The question of housing industrial workers should also be considered in choosing the site. It is advisable that their residences should have proximity to the city zones and at the same time separated both from the city and the factory. A green belt of parks and gardens should separate the residences from the factory. From 500 to 1,000 yards might be considered reasonable for its width.

[1] Report of the Barlow Commission.

[2] The principle of isolation and segregation of industrial residences is now recognised by Government in Great Britain. In dealing with a proposal by Messrs. H. G. Cuff & Sons recently, regarding the development of land zoned for industry for residential purposes, the Ministry in their recommendations suggest that in dealing with plans for the development, they should consider the lay-out from the point of view of A.R.P. " In considering this aspect of the matter the Council came to the conclusion that protection of the civil population from air attack could best be secured by isolating the areas which are most likely to be the object of attack from the air (*viz.*, factories) . . ." (" Ministry of Health Appeals." J.T.P.I., November-December, 1939, p. 11).

In European countries it is now realised that the industrial worker has to spend a good deal of his time and money on travel to and from work. In England it has been estimated that expenditure on transport by public conveyances within the London Passenger Transport area comes to about 15 pounds per family per annum or about 8 per cent. of the average income of working-class families in London. This great waste will be avoided if industries and houses were suitably grouped in garden suburbs near the large city. Only one industrial suburb is shown but according to the needs and facilities more might be located at convenient spots. The question of size is difficult to decide. After careful investigation it has been found that industries employing 10,000 workers are justifiable. Expansion of Industry would be possible by total relocation, or by ancillaries located on the main national speedway and the railways.

Universities, Libraries and Art Galleries

The University and seats of higher learning must be drawn out of the busy areas of the city, for obvious reasons. From the increasing importance attached to residential universities and colleges it would be evident even for peace times this is necessary. At the same time access to the city should not be cut off. Tranquillity, peace, and healthy atmosphere cannot be obtained if they are situated in the hearts of cities. Other educational and allied institutions might also be similarly located.

Especially Libraries, Museums and Art Galleries should be located away from city zones. This is the lesson Nazi raids over Britain has taught us.

When the Nazis attempted to destroy the city of London by fire in December 1940 by dropping hundreds of incendiary bombs, great damage was done to many historic buildings. The Guildhall was gutted and its library considerably damaged. Many valuable works were lost.

The Royal Empire Society's building in London, which is well-known to visitors all over the world, was severely damaged in an air raid. Practically the entire law library involving between 12,000 and 15,000 books was destroyed. In addition, between 10,000 and 12,000 books were destroyed in the newspaper room including the whole of the British Empire Section.

Other losses involved are a complete section on foreign colonisation as well as the irreplaceable foreign periodicals and official journals of the former German and other colonies. The entire collection of books concerning East Africa and Gibraltar and Malta sections were also lost. Administrative quarters, together with the Indian room, New Zealand room and social rooms were gutted.

In Goldsmith College about 12,000 books were destroyed; the King's College (London) Library; the Inner Temple Library and the Public Libraries of Liverpool, Plymouth and Richmond suffered the same fate.

The Birkbeck College Library has been almost completely destroyed, as have many thousands of books in the National Central Library.

Six million books were destroyed in and around Paternoster Row on December 29, 1940 during the incendiary bomb raid on London. The premises of thirty-seven publishers were damaged or burnt out.

Many burned books will never be reprinted. Of the six million books destroyed in the Paternoster Row, it is said that many thousands of titles will never be reprinted. They are a dead loss to publishers. About half the books destroyed belonged to the famous wholesale house of Simpkin Marshall and the remainder to about a dozen leading publishers.

According to Mr. Stanley Unwin "the scholarly books, for which the demand is limited, it will not pay to reprint. At least a thousand titles in my own list, for example, will go out of print when our limited bound stocks are exhausted. Of the 1,400,000 books destroyed in which I was personally interested, only a small proportion will ever be replaced."

Libraries should therefore be located like Universities in safe places. Their construction and design should be such as to be fire and blast resisting and offering safe places in strong basements for keeping rare manuscripts and micro films of famous books. This would obviate the need for keeping micro-films in mines and tubes deep below, as is being done now in Great Britain.

Art Galleries and Museums housing the relics of civilization and culture should be similarly located. Recently the value of

dispersal of a country's historic and art treasures was emphasised by. the Director-General of Archæology in India. He rightly deplores the accumulation of historic relics, which are irreplaceable, in large museums in cities extremely vulnerable to air attack. He pleads for the retention of the valuable relics in places where they are discovered and suitably arranged which would give a further advantage in that they could be studied in their natural setting.

Such location will make it unnecessary to remove art treasures to other places during emergencies, as is being done now in several cities threatened by the risk of air attack. Even if sufficient expense is possible it may prove harmful to shift the relics in many cases. Frequent shifting will be avoided by careful location and design and construction of Art Galleries.

Size and Shape

The determination of the size of the ideal city, raises difficult issues. Local features and requirements, municipal finance, civic amenities to be provided, etc., would be the governing considerations. Although cities in India cannot compare in size with those in the West, some of them are large enough and have developed the evils gripping European cities. Thirty-eight cities contain over hundred thousand inhabitants and two of them over a million. The Royal Commission on the Geographical Distribution of the Industrial Population of England arrives at the conclusion that it is not practicable to define when a town has reached the maximum stage, either in size or in extent. It is suggested that considerations of space and distance in the case of the larger urban areas, involving problems of transport and traffic congestion, should serve to mark the stage when decentralisation must be contemplated.

Mere size need not in itself be a disadvantage, but it is size without system, chaotic growth without the adoption of proper principles of planning alike for social well-being and for industry, that are to be avoided. But the Commission seem to think that there is something to be said for a city with a million inhabitants. The optimum size for India would be smaller considering the predominance of agriculture in her national economy. Perhaps half a million might be fixed as the limit for population and 50 to 60 square miles as the maximum size. The open pattern for residential suburbs and decentralised supply of essential services would make

possible the management of the city with the normal taxes and income from the city. Expenses now incurred upon curative measures would be avoided and the municipal budget reduced to the smallest dimension.

But cities grow and it is difficult to put a stop at any particular stage even if it were possible to discover what the correct stage is. Three methods have been suggested to control urban expansion.[1] One is an embargo on all building within a fixed distance from existing boundaries, thus providing a green belt from ten to twenty miles in width ; another is a combination of this method with the development of satellite town ; the third is the use of a system of radial development. These are put forth to prevent cities from extending to unwieldy proportions without placing unwholesome restrictions.

The first is drastic and impracticable. The density in urban area would increase by natural expansion and when the district begins to decline in prosperity the trades will be transferred to more free areas, and give rise to other problems. This defect is also present in the second method.

The development of satellite towns would have to be accompanied by some provision for their limitation of size, as otherwise they would become rival centres to the parent city and would create again the same problems of control. Limitation of size, however, would result in the creation of many such areas because of the rapid growth of population, and the multiplication of small satellite towns could hardly be a desirable feature.

A system of spur development defining directions and limits within which urbanisation would be allowed, would provide a solution to the problem which would not suffer from these rather serious defects. The result would be the creation of spurs linked like spokes to the central hub and providing for open country between as a general amenity and for agricultural purposes. Provided that the width of these spurs was limited to approximately two miles the open land need never be more than one mile from any of the newly developed districts, and yet proper development would not be restricted but would only be controlled in direction. Contact between the various areas would be maintained, proper amenities would be preserved, and the products of agriculture would have a

[1] *Vide* J.T.P.I., February, 1940, p. 41.

market ready to hand. Road communication would be made easier, and could lead directly from centre to centre without restriction. Ring roads could be built more easily, since they would be largely across country without development alongside. Railways could run along the spurs supplying premises on the route and airports could be sited near to the areas they were designed to serve instead of many miles away, with the consequent loss of much of the time saved by extra speed in travel.

The circular design is therefore helpful to control the size of the cities as well as to facilitate the development of the surrounding country, and even where development alround is not practicable as, for instance, on a coast, the main principles could be followed. The circular plan has been recommended by well-known experts in Town Planning. Sir Raymond Unwin has emphasised the need for maintaining a sound relation[1] between the town and the country, the rural and the urban economy and for urban folk having easy access to the extensive open country, and concludes that open green belts should surround urban areas and intersperse residential units of families. Says he : " One type of design which fully meets these conditions, which while facilitating the desirable pattern in detail for each urban unit will provide a plan for expansion, and will allow the units to grow in number, and to be federated into the larger groups demanded for the support of many modern economic and social activities ; that form consists essentially in a central unit or town, planned to reach a certain maximum size, within which the right detail, relations of parts, or the pattern, can be maintained. Further growth of population would be provided for by planning of new units of urban development, each as complete as possible, intended to localise the daily life of the inhabitants, while securing such relation to the parent town as will open its greater central opportunities to all who need them, and secure that the new units are at once linked to the parent unit by easy communications, and separated by a sufficient background of open land to maintain definition and satisfy all the needs already referred to both of the centre and the satellite units as we often call them."

The circular plan is further considered helpful for political progress, and as indispensable for the preservation of democracy and democratic ideals. Perfect equality of situation is secured by

[1] " Urban Development, the Pattern and the Background."

settlement in a circle and among the nomadic peoples who, though their numbers might increase, only met periodically for a religious festival or marketing, the circle in which they pitch their tents is easily enlarged. The circular plan appears to be actually the basis of some of the earliest built cities. Other advantages are also claimed for the circular plan. It obviates the popular objection to the perfectly straight facade, and helps to give individual tones to groups. The proper arrangement of a group that is not too large to allow scope for the individual, is the square or crescent of houses representing the original ring settlement.

" Living in such cities we should be, as it were, seated around a table and we should know what that means. People who enjoy life within sight and hearing of one another cannot avoid developing feelings of generosity and kinship."[1]

A city formed by several small and compact communities located around the chief commercial and administrative areas will satisfy the criteria postulated by Aristotle for preserving democracy. According to him democracy could not survive in a city too large for the town crier's voice to be heard throughout it. Anything which guarantees the equal dissemination among all the citizens of the knowledge of events as they happen, and an equal opportunity of the response of each citizen being heard, is a guarantee of democracy, and the ground plan of a city has much to do with this. The formation of that powerful force, public opinion, fails to-day because of the geographical isolation of sections of the population in inaccessible parts of the cities or in the country where so many people are refugees from the unbearable towns.

The Greeks planned their cities for democracy and although representation renders restriction of size not essential the principle expounded by Aristotle is valuable. " Equality of situation for all its citizens in regard to the enjoyment of the public amenities and common services which the city exists to supply." This requirement of democracy is also good for defence. A circular city has less perimeter to protect than one of equal area rectangular or square in shape. Active defence would be easier as also protection by land forces of the city's boundary. Economy in anti-aircraft guns and balloon barrages will also be secured. This need cannot be over-

[1] J.T.P.I., November-December, 1939, p. 23.

looked for reasons already explained but the plans and details are best entrusted to the defence department.

These are the essentials of air defence for modern urban communities and cities planned and laid upon these principles can be considered safe for all practical purposes. How can a change in the pattern of our existence prevent the enemy from sending bombers to raid. But a careful examination will show that destruction will be reduced to the minimum to city structures and dislocation will be nearly impossible and citizens would be absolutely safe. This may not make air raids impossible, but will defeat the purpose of the attempt and render it wasteful and ineffective. These would make raids not worthwhile and ultimately impracticable. Herein lies the chance for cities and civilization to survive the air menace.

Even if more powerful weapons are discovered and brought into use cities built as suggested would render possible effective precautionary measures and precautions would pay. Added resistance could thus be secured and more deadly raids could be defied.

The expense and effort of preserving civilization and culture in its modern abode—uncontrolled agglomeration of men and buildings—is prohibitive. Three hundred and sixty thousand pounds a day are needed for partial evacuation and A.R.P. Organisation for England ; not to speak of the nine million pounds expended every day to resist aggression mainly from the air. Is it too much to ask then to spend much less to obtain much more—a permanent abode of peace and security for man and his material culture ?

The peace-time advantages alone are sufficient to recommend a change in the pattern of our existence towards the ideal described above. Re-shaping existing cities is worthwhile and a long time view of municipal finance and civic economy would justify and warrant the attempt. The expense needed in times of war for protection makes this change imperative.

Bomb-resisting Cities

This pattern has the advantage of preserving the normal life of the people in healthy surroundings and avoids the difficult solutions suggested to produce bomb-proof cities by Le-Corbusier and Air-Commodore Charlton. According to the former, the city

will be deep underground; the railways, roads and factories, and power-houses would be out of reach of air bombs; nay the entire city! Suggestions have also been put forth to solve the various problems that would arise as a result of locating cities deep underground; such as lighting, power production, etc.

Air-Commodore Charlton, however, believes that bomb-proof cities overground are possible. His plan consists of fifteen-storeyed dwelling towers, cruciform in shape as to ground plan. Each arm will end in a T-head and similarly crossed twice between head and centre joining. From above they will resemble two equal lengths of codfish backbone laid crosswise. Circular-shaped reservoirs, one to each group of four towers, would provide a never-failing supply of water for fire-fighting purposes whatever damage the mains or pumping stations might suffer. They will look like noughts.

According to Charlton,[1] the dwelling towers would be widely spaced and stand separate, nothing in the shape of built-up streets or, walled enclosures which might retard the dispersion of gas, being permitted. The life of the place will go on in these tall erections, each of which will be connected with its neighbours by deeply situated underground passages. The wall would be of concrete, as also the foundations, and an apron of concrete 12 feet thick, would be laid as a wide footing, so that a bomb explosion nearby may not jeopardize the main structure. The flat roof will be of reinforced concrete, 10 feet thick, and the attic storey lumbered up with material, such as cement and compressed wool bags, best calculated to resist the passage of a bomb.

A bomb-proof city with overground dwelling towers

Each edifice would be housing 1,500 persons in the eight storeys beneath the attic, the remaining six, from the ground floor upwards, being dedicated to a different use. The idea is to obtain the maximum possible security at one and the same time against the three forms of aerial bombardment, high explosive, gas, and

[1]L. E. O. Charlton: War over England.

incendiary bombs. The plan of the buildings should be designed to afford a minimum surface on which a bomb might strike, and the constructional material of roof, walls, foundations and footings, to be capable of resisting penetration and impact. The water-reservoirs secure the means of fighting flames if an incendiary should take effect.

As regards gas protection, more necessary than the other two, the inhabitants only dwell in the high-up part of the building, the altitude of which places them out of reach of the low-lying gas clouds. They could breathe pure air at all times, and if necessity compelled them to go down, the masks and special clothing which would be universally provided would protect them during a short absence.

The ground floor, and the five storeys above it are to be adopted for non-living purposes, shops, markets, theatres, cinemas, restaurants, and all other amenities of town life for the use of the public at large in a sense of non-privacy. These lie within the gas zone, it is true, but they could be immediately evacuated in case of alarm and the people could ascend to their upper floors. " In this way herding in subterranean shelters in conditions of fright, artificially ventilated, with the knowledge that gas lay all around outside, the danger of imprisonment from overhead collapse, and all the other serious objections to that form of security is avoided. Private life undergoes a minimum of disturbance and the gas peril ceases to exist."

Such a town of " Noughts and Crosses " is also bomb-proof as regards its ordinary water service, its electricity supply and its telephone system. These are canalised in concrete, underground conduits running side by side simplifying inspection and repair, and permanently laid. Drainage is to be conducted in the same way. Lighting would be diffused from the curb and one main switch could plunge the town in outside darkness. Overhead life will proceed normally in normal times and the life would be happy.

Balloon barrages, and machine-guns would guard against low-flying attack ; searchlights, obstacles and aerial mines would meet high bombers. In certain special localities these means might be supplemented by smokes and camouflage.

Town Planning and Air Defence

A deep underground city or a "Noughts and Crosses" might become indispensable for a highly industrialised country where scope for lateral expansion is slight, but they are neither necessary nor practicable for a poor and vast agricultural country like India. The open pattern for reasons already explained would obtain as much security from air raids as these cities and would be very much cheaper. And while those patterns may secure air safety they cannot help to achieve the balanced dispersal of population and industry and the correct proportion between urban and rural interests in the nation's social economy. The open pattern described is essential to give the nation the proper physical basis for developing a stable and healthy civilisation. The Memorandum of Thomas Adams on "Town and Country Planning during the War" circulated for the information of planning authorities in England and Wales lays special emphasis on the balanced development of the nation as a whole. "What is most vital is that the nation should be planned in its units of urban and rural areas in order to promote most efficiently the wealth-making activities of its population and to provide them with higher standards of living and working conditions."

Planning in its most comprehensive sense alone can thus obtain air security for India by re-grouping and locating her population and industry in towns and villages in suitable proportion. That planning is necessary to meet the air danger, and re-planning existing cities on proper lines alone can help the survival of cities and civilisation is now recognized by leading authorities and governments of Europe.[1] Legislation with this object in view is gradually developing. In France the height of buildings is subject to regulation with reference to the width of the road. According to an order issued in 1938 in Poland "all new urban developments must be planned in sections of irregular form. Roads and streets must be straight and should run in the direction of prevailing wind, leaving at least 60 yards between the fronts of buildings on main thoroughfares."

Forty-five per cent. of the area developed must be left as open space used either as recreation grounds, aerodromes or for agriculture. Industrial districts must be laid out in small widely separated

[1] Sir Alexander Rouse: "Town Planning in Relation to Defence." J.T.P.I., December, 1938, pp. 39–46.

areas and the ratio of industrial districts to the whole town should not exceed 1 : 7.

Modern dwelling house of over 2,500 cubic metres must have an air raid shelter for the residents. The shelter must have two entrances, one of it must be beyond the area which would be covered if the building were to collapse.

Closely built-up areas in existing large towns must be broken up by the introduction of open spaces.

In Turkey also precautions for resisting air attacks have been incorporated into the country's town planning laws. The Turkish Town Planning Law and Civil Defence Act states that methods of passive defence must be applied in town planning and the determination of the sites of important buildings. It lays down among other things[1] :—

1. In defence areas the proportion of a site occupied by dwellings must not exceed 30 per cent. of the total.

2. There shall be at least 20 metres (65 feet 6 inches) between each masonry-built building and 30 metres (98 feet 4 inches) between wood buildings.

3. New buildings must have as few storeys as possible.

4. Height of buildings on either side must not exceed 75 per cent. of the distance between the buildings facing each other.

5. Detached buildings are to be preferred to attached and continuous.

6. In districts where there are many important buildings the roads should be open as far as possible in the direction of the prevailing winds.

7. When new constructions are made in towns, villages and industrial centres the local authority must see that the buildings are placed so as to be as inconspicuous as possible and so that the fullest possible advantage is taken of the lie of land and the trees.

In the planning of large and important public and private buildings it must be assured

1. that buildings of this kind are not grouped.

[1] *Vide* J.T.P.I., September–October, 1940, p. 200.

2. that except where they cannot be spaced so widely there must be at least 100 metres (328 feet) between each.
3. that they are as far removed as possible from places such as military posts, railway stations and aerodromes which may be the subject of bombardment.

Telephone, electricity and gas works and exchanges should, if time allows and if it is possible otherwise, be built underground. If it is not possible they must be concealed as far as possible and secondary supplies provided to assure the services in time of need.

In plans for the restoration or enlargement or improvement of towns and villages future population density must not exceed an average of 154 persons per hectare (62 per acre) distributed in each district according to the needs of passive defence.

The Town Planning laws of Germany go further and regulate the distribution of industrial production, choice of sites, size of plants and their lay-out, as well as works operations and supplies. "Under the town planning regulations of the Reich and Federal States, the construction of new plant or extension or alterations must be so carried out as to achieve a marked decrease in the vulnerability of German industry to air attack, with a view to re-distribution of industry so that finally industrial production will be spread more or less evenly over the whole country." The choice of site should, in the interest of air protection, be not conspicuous from the air and workers' houses should also be kept well away from the works. To minimise the destruction to productive plant, measures are in force to deal with the size, position, and nature and method of operation of industrial plants. From this point of view many small buildings irregularly scattered over the site are preferable to a few large ones in ordered rows, and it will be the works engineer's task to satisfy in his lay-out both the economic necessities of the plant and air protection requirements.

To restrict the effect of an air raid to a part instead of the whole of the plant, the various buildings comprising the plant should be separated from one another so as to segregate the works' processes to some extent, and in large works technical and administrative departments are recommended to be outside danger zone of the

plant. The provision for an alternative supply of electricity, gas, and water is specially stressed. A sufficient large strip of unbuilt land must be left between the works and the workers' houses and they must be laid out some distance away from the works. Shelters for small houses should be constructed so as to serve as storage cellars during peace times and must be built with solid ceiling, the entrance being rendered splinter and gas-proof by such make-shifts as sandbags, sand-boxes, stone packing and the like. If the houses are flats likely to be bombed the shelter must be in conformity to official regulations.

Reliance is placed on dispersion. It is aimed at extending Berlin over twice its present area without increasing its population. No house would be allowed with more than six floors.

Researches made in Germany regarding the relation of Town Planning " to the total economical life of the nation in its future form under State control " are considerable. And the investigation of Stadrat Niemeyer, President of the German Academy for Town Planning, Reich and Regional Planning, pays attention to the question " How does protection against air attack affect the position and a territorial distribution of Industry and Commerce expected?"

Even in Great Britain considerations of Air Defence are influencing Town Planning. The Civil Defence Act has made the following important additions to the Town and Country Planning Act, 1932.

There shall be included among the general objects for which a scheme may be made under the Town and Country Planning Act, 1932, the object of rendering the whole or any part of the area to which the scheme applies less vulnerable to air raids, and that Act shall have effect accordingly as if the said object were included among the objects enumerated in Section 1 thereof.

In future, therefore, the machinery of planning schemes will be available as a means of rendering an area less vulnerable to air raid. The Town Planning Institute after careful consideration finds in general that it could be readily adopted to deal with this new objective and the amendments they propose have the effect of making it certain that the object of safety from attack from the air shall be taken into consideration in all appropriate cases. They also suggest appropriate dimensions and proportions with regard to

space around buildings, maximum proportion of site to be covered, the height of buildings and the width of protective buffers of open space, etc.[1]

The requirements of air defence and principles of Town Planning agree on many fundamentals. As pointed out by the Council, " there is a considerable measure of agreement between the generally accepted principles of planning and those of A.R.P. inasmuch as large concentration of population or industries and crowded developments are bad from both points of view." Although the whole life of a civilised community cannot be planned on a war basis the eventuality must be taken into consideration and planning our requirements should be adopted to minimise to the maximum extent, the dangers of air attacks.

The fundamental principle governing A.R.P. in relation to Town and Country Planning is dispersion, and this is possible if the groups are kept relatively small and have an open pattern.

Secondly, the road system should consist of through routes clear of building development, and commodious in centres of population.

The lay-out of administrative buildings, national and local, should be spaced apart, decentralisation should be encouraged and provision made for suitably placed alternative accommodation to be available in case of need. While their grouping necessarily increases vulnerability from attack from the air, the practical and social advantages of grouping and zoning are predominant.

The single family house at a density not exceeding twelve houses per acre is considered the best form of development. Large multi-family dwellings are therefore undesirable and where indispensable, should be widely spaced and provided with air raid shelters. Their safety is enhanced by interspersing small parks, playing fields, and allotments.

A.R.P. demands that industries must be widely dispersed, but experience shows that a certain amount of grouping is essential regarding communications, homes, power services, raw materials, markets and ancillary industries.

[1]Memorandum of the Town Planning Institute on " A.R.P. and Town Planning in Great Britain."

" Large concentrations of industries should be avoided and in all cases they should be well separated from residential areas by a belt of open space. Industrial areas and warehouse areas should be laid out on spacious lines so that the buildings can be spaced wide apart. A spacious form of lay-out will minimise the risk of direct hits, will provide fire breaks, and will afford facilities for the digging of shelter-trenches for the employees."

"The relation between home and place of work is of considerable importance as ease and comfort of communication is desirable both in peace and war. A relatively close relationship separated only by a buffer of parks affords an ideal solution as it should meet the needs of convenience, safety, recreation and amenity."

Ribbon development is undesirable in peace times but as it makes easily distinguishable mark from the air, they are unfit for air defence. Developments in small groups related to but not lining main roads, railways, rivers and canals should be preferred.

Whenever opportunities occur towns must be re-planned on these lines to encourage decongestion and dispersal; the development of holiday camps is also emphasised as useful for children as well as for adults.

How these general principles should be applied? For instance an adequate area of open land within industrial and residential areas is always desirable but is of particular importance in relation to safety from air raids. Warehouses storing essential commodities are liable to attack and need separation from residential areas. On the question of the width of the buffer it is felt that " the appropriate width of the buffer will vary according to such circumstances as the configuration of the ground, and whether industries or warehouses are likely to form a particular object of attack (*e.g.*, electric power stations, gas-works, docks and warehouses, waterworks, aerodromes, armament works, food stores), and whether the industries themselves are likely to spread havoc if hit (*e.g.*, explosive factories, oil refineries or stores, varnish works, timber yards). It is suggested that the width of the belt might vary from 100 to 400 yards according to circumstances including adequacy in relation to appropriate peace-time use.

Possible peace-time uses for such buffers would be parks, playing fields, allotments, private open spaces, and possibly cemeteries.

The Town Planning Committee lays emphasis on space about buildings and suggest modifications to existing Clause 42 of the Town Planning Regulations of Great Britain in view of the importance of open pattern of development and of a spacious form of lay-out, for industrial and warehouse areas. The following maximum is suggested for the proportion of site which may be occupied by buildings.

Dwelling houses, residential buildings, other than blocks of flats, places of instruction and institutions	1/4
Blocks of flats	1/6
Other buildings	1/3

The breaks between buildings are also emphasised. They suggest alterations in accordance with the requirements given in A.R.P. Handbook No. 9. The safe fire break (distance between buildings) respecting buildings of low fire risk is given as 30 feet. They suggest a minimum standard of 30 feet should be applied (15 feet as between the building and the boundary). Regarding Industrial buildings they consider 40 feet suggested by A.R.P. Handbook No. 9, necessary.

The possibility of collapse and debris falling off to other buildings or blocking roads or foot-paths is a fresh consideration, with regard to the height of the buildings. Its limitation is necessary to keep the roads free from being blocked. Having regard to A.R.P. they recommend that one angle only, namely, 45 degrees should be specified as a general guide.

The siting of buildings is also emphasised to enable the development of adjoining estates to be properly related and access to be safeguarded. Finally they remind us that authorities should bear in mind the value of trees as a screen from observation from the air. The preservation of trees becomes a question of outstanding importance.

The principles of air defence lead to garden city types—a federation of residential suburbs with a suitable proportion of non-residential zones. Lateral expansion is essential to re-shape existing cities to conform to this ideal. This is not difficult in our country where most large cities are surrounded by level open country. A series of satellite towns would serve as district head-

quarters, marketing and industrial centres, and other important towns. Factory centres would do well to retain more the complexion of garden cities. A "hundred small towns" ideal could be achieved which would restore the lost balance between town and country as well as the homogeneous distribution of towns and villages. In making India proof to the air danger, her industries and factories would be suitably dispersed and located, not merely with a view to ports and capitals but also their efficient distribution over the country.

Thus a network of air raid proof provincial and state capitals surrounded by suburbs and connected with garden towns, satellite towns and industrial centres, holiday resorts, places of pilgrimage, etc., serving as the fountain-heads of rural betterment, and with the seven hundred thousand villages suitably grouped forming the back-ground, would obtain air security for India. The importance of passive defence cannot be exaggerated in this vast country of poor finances, both central and provincial. To defend a territory less than a tenth of ours in extent it costs Great Britain ten crores every day.[1] When sixty crores a year upon defence is considered an intolerable burden upon the poor peasants of India, can our country bear to spend hundred crores a day?

Reconstruction and National Planning

Attention is now being drawn in England by experts to 'the geographical or aerial aspect of the structure of community life' in the interest of security and safety in peace and war. Planning should provide scope for satisfying the needs of the community and every individual who is a member. This is possible only if the problem is approached on lines disclosed by the Science of Human Ecology viewing man as part of his environment.[2] Robert E. Dickinson, emphasising this need for the ecological approach to

[1]The amount of further expense modern cities will entail will become apparent when we take into consideration compensation for citizens for death and injury. The whole adult population of the United Kingdom is covered by a scheme of compensation for injury or death due to enemy action. The scheme announced by Sir Kingsley Wood, Chancellor of the Exchequer, provides for weekly payments, varying between 35 shillings and seven shillings according to the category of the person injured. Pensions will be payable in cases of long-term disablement, while the widow of a civilian worker whose death was due to enemy action may receive 50 shillings weekly for the first ten weeks following her husband's death.

[2]Robert E. Dickinson: "National Planning and the Social Sciences," J.T.P.I., May-June, 1941, pp. 114-119.

'physical reconstruction' and town and country planning, observes that it is a task for the social sciences to establish the nature of the functions of village and town in selected regions and to determine the extent of the areas served by them.

This is the geographical aspect of the background of the social and economic structure of society upon which nation-wide plans for the future must be based. Rural settlement is grouped in two forms or variants of them, namely, the compact village or isolated farmstead. The need for regrouping the rural population, and the bases upon which it should be attempted have been given singularly little serious attention. The unit rural community area should be large enough to support a church, a school, village clubs, and the ordinary retail services. A minimum population figure may be arrived at by considering the requirements of these services, and it is suggested in common with proposals by others. In fact this kind of proposed rational arrangement exists in the grouping of the urban village and the several parishes which it serves. These urban villages, together with the towns, which clearly carry on the same local services, are spaced at intervals of some four to six miles, with service radii of some two to three miles. The town is a compact settlement, which is engaged primarily in non-agricultural occupations.

Dispersal of population from the great cities calls in large measure for the creation of new towns. In planning, the aim should be a balanced community life and the close integration of the life of the town with that of the surrounding countryside. If attacked on a grand scale, scores of such settlements will have to be created. Entirely new towns, on virgin land, will not only eat up agricultural land, but they must be imposed upon the existing warp and woof of service relations, which have their nucleii in the existing towns and would lack the historical and social tradition of the latter. All these defects, for example, must be set against the advantages of life in Welwayn Garden City.

The optimum limit of the smaller town cannot be clearly stated. The population should not exceed the limit beyond which the consciousness of social unity breaks down, but should be large enough to maintain efficient communal services, *i.e.*, about 25,000 inhabitants. Such regions with their capital cities actually exist as the basis of the present geographical structure of our society, as real units of economic life and orientation.

With the built-up area of the urban complex proper, the specialisation of function is reflected in the geographical segregation of distinct socio-economic areas, in which common social conditions form the framework of the social behaviour of the individual. This is not a question of broad zoning in the sense of the town planner, industrial, commercial and residential, but of detailed analysis of land use, population density, age composition, family budgets, mobility, etc., all of which data can and should be mapped so as to determine both the character and extent of the socio-economic areas.

The lay-out of new dwellings, be they houses or flats, must be conditioned by the provision of community services. Services in the heart of the cities, like hospitals and churches, built at a time when their clientele was near them, are now wrongly placed from the standpoint, of efficiency and service and should be shifted to the city outskirts. Community services must be provided for existing suburban estates, and new planned areas in the city centres should be so designed as to cater fully for needs.

The unit area of urban life must permit the growth of the community sense which exists in the slums. The size of this planned "city village" should be no larger than the rural unit, *i.e.*, about 1,500 to 2,000 inhabitants, or about 400 to 500 separate dwellings. "We want no more unplanned (with no apologies to the town-planner) Dagentham estates or Kennington flats."

It would appear then that the analysis of the geographical structure of society, in town and country, with respect to the character and extent of the existing service and community areas, and to the minimum needs of the different types of services, be they social, commercial, cultural or administrative, affords a sound and essential basis for the planning of communities in the city, the town and the country-side. This, however, is not a problem for the geographer alone, nor for the economist, nor for the sociologist. It is a problem which demands a discipline of its own, to which all the social sciences will make their contribution and is likely to be one of the most fruitful fields of research in the social sciences in the ensuing years.

The problem has been grasped in the United States, and more recently in Germany. In the former, where it is known as Human

Ecology, there is already a large body of research to its credit. The present conflict has turned the attention of scientists as in the last war to the problems of internal reconstruction, and they are, in large measure, now facing the same unsolved problems. Today one hears on all hands of planning and the launching of research on economic and social surveys, which shall serve as a basis of such planning. 'In true British tradition, the problem is not looked at as a whole and attacked systematically; but is approached empirically, from special points of view in connection with some particular problem.' It is absolutely essential in the interests of efficiency, speed and scholarship, that the various points of view build up a common basis of attack and objective.

Herein lies the opportunity and the duty of the social sciences, to elaborate principles and standards for the future planning of settlement on the land and in the towns, and for the re-organisation of the local government areas.

Already there is great popular interest in England, in spite of war difficulties in post-war reconstruction and Lord Reith, the Minister for Works and Buildings, has lost no time in getting down to his formidable task. Twenty-one distinguished persons have been selected to form his Consultative Panel on Physical Planning. They represent a wide variety of interests, and it is gratifying to note that the importance of architecture and town and country planning in the work of national reconstruction is recognised by the inclusion of no fewer than eleven direct or indirect representatives.

The task put before Lord Reith is (1) to study comprehensively the whole tangled web of the country's planning activities, with their different administrative controls; and (2) to draw up for the Cabinet a scheme for the constitution of some central authority to be entrusted with the production of a broad national plan for post-war Britain.

Test surveys of the Coventry, Birmingham and Bristol areas have been undertaken and the local authorities have been told to plan for reconstruction "boldly and comprehensively."

A Committee (presided over by Mr. Justice Uthwatt) on Compensation and Betterment has been set up to report upon these two complicated problems.

An interdepartmental committee has been appointed in the hope of adjusting the claims of the various separate authorities concerned with the replanning of the country.

A consultative Panel has been set up and staff experts appointed.

However busy they are with building for the war there is time to spare for that which constitute that happy moral responsibility to consider and report on methods and machinery for reconstruction.

The proposal for planned rebuilding of towns which have suffered heavily from air raids has been announced by the Chairman of the War Damage Commission, Col. Trustram Eve. In some sixteen cities, including London, Birmingham, Coventry, Liverpool, Plymouth and Sheffield, the power given by Parliament to prohibit rebuilding except with the permission of the authorities has been exercised with the result that no rebuilding could take place until those concerned with good planning had completed their scheme. Comprehensive legislation dealing with the whole subject of planning is contemplated.

To facilitate rebuilding a less vulnerable capital, the City Corporation of London is considering the question of purchasing the land within its area. The *Daily Herald* has given out a figure of two hundred million pounds to secure municipal ownership, and London will be the first city in Britain to acquire such public ownership. The ratable value is to be added at £8,300,000 per square mile which brings the capital site value to something like 220 million pounds.

It is interesting to note that expert opinion in Great Britain is tending towards the 'open pattern' even for a city like London.

"The London Problem," according to Major Maxwell Fry, "is concentrated in the provision of good housing, opportunities for adequate leisure and healthy work places, these three elements being linked by efficient transport services. These four elements, work, leisure, housing and transport—are completely interdependent and form the basis of the problem."[1]

According to him housing proposals should be based on a social structure built up of the following units:—(1) Residential unit of

[1] *Vide* "Builder", April 18, 1941, p. 392.

1,000 people, of which the nursery school and the every-day life of the people form the basis; (2) neighbourhood unit of 6,000, which give the right number of children in the elementary school age groups (480 from 5–10 years and 480 from 10–15) for an efficient school structure; (3) the borough or town unit of 50,000 people—a size which make a full measure of social life an economic possibility; (4) the city district or small city, comprising twelve such borough units grouped together and (5) the city—ten such districts as in (4) forming the city or metropolis of 10,000,000—a figure to which every effort should be made to restrict the present population of London.

Playing fields for schools, 16,000 acres; for factories and offices, 30,000; open play space near the home, 15,000; and private gardens, allotments and rest areas, 15,000—a total of 76,000 acres. The proposals included the reservation of a ten-mile week-end zone of purely rural country around London and the reorganisation of holiday resorts on sea coasts within 50 miles of London.

All sidings and marshalling yards would be planned at the extremities of this main artery and outside the circular connecting railway, thus freeing large central areas for parkways and redevelopment.

The city districts are to have each a goods station at the extremity of the transport lines, and these would be linked by a circular rail and road service to the industrial zones so that goods distribution is segregated from passenger transport. Local traffic is served by roads running between city districts crossing the pendulum traffic lines by flyovers.

In a series of three articles written by him to the "Star" on replanning London, Mr. Thomas Sharp, after advocating the demolition of much that German airman leave standing, feels that the London of the future should have a central city of three million inhabitants, surrounded by satellite towns with population of a lakh each, the whole interspersed and repeated by wedges and rings of open land and held together by a series of planned communications free from stopping traffic. "The new London must be based on life, not on scientific theories." "The City Beautiful is an expression wider than bricks and mortar, buildings or elevations; relates far more to the lives of the people than to external appearances, symmetry or design."

The need for investigation and study and research to formulate a national plan on the lines of which reconstruction should proceed has now been emphasized by technical institutions dealing with planning and architecture in the west. The R.I.B.A. Reconstruction Committee, in their interim report, lays special stress upon "the immense tasks of study, analysis and research which must be undertaken preparatory to the definition of a national plan. The first task of all concerned in the rehabilitation of a country is to come to clear ideas of how research can be organised. Anything less than the most thorough, exact and expert research will not suffice if national planning is to have a secure foundation and if it is to be alive."

Proposal for building actually an experimental town has also been made. It is suggested that the Government should build an experimental town now on a freehold site purchased outright by the State, and designed on modern town planning principles, the size of the town to be statutory, and not to exceed, say, 100,000 inhabitants. They are spending over ten million pounds per day on the war, so for less than one week's expenditure could build this ideal town and show what can be done. From this experiment many useful lessons could be learnt for future guidance, and the work accomplished would be one of the finest investments in the world. An air survey would be useful, for many a building project has been ruined by badly selected bricks, timber, paint, etc. A large scale model would show all the contours, natural features, and buildings of archæological interest to be preserved. Such a scheme might take four or five years to build, and perhaps longer finally to complete, but would remain for ever under architectural control, and all new buildings would conform to the general plan.

There must be no standardisation in design, but there can be no objection to standardising bricks, tiles, drain-pipes, and so forth. Only thus can a comprehensive plan which will satisfy all, could be built.

The task of distributing the population and industry of a country on a balanced spacial basis, wherein the proper relationship would be maintained between the different units, social, economic and geographical, composing the nation cannot be achieved without a national organisation or a National Planning Commission, solely entrusted with the task of formulating plans and programmes for

the permanent redistribution of population and industry and the reshaping of cities, towns and villages with a view to make India invulnerable to air raids. Our conception of town and country planning should change fundamentally to a new sense of values.[1]

Without a plan for the whole nation, no lasting betterment is possible and no plan will succeed which does not have the welfare of the people as the highest goal and which forgets that man is essentially a "*human and social being.*"[2]

The Royal Commission says in its Report on the Distribution of the Industrial Population of Great Britain, rightly: "A National Plan, conceived as a whole, would be likely to differ substantially from a National Plan constructed by merely piecing together the local and regional plans. The local and national interests may easily clash." This idea is finding increasing agreement, so that, but for a few exceptions, the urgent need for a nationally-conceived plan is meeting with general approval to-day.

In the course of the last few years, certain broad principles have emerged from general discussion and from an objective survey of the situation with regard to town and country planning. The most firmly established of these principles is the decentralisation of the big urban conglomerations. Various remedies have been suggested. Most of these are, however, restricted to new settlements of a merely urban or semi-urban character.

These will obviously combine industrial and agricultural work so that the countryman of tomorrow will be a part-time worker in both agriculture and industry.

The chief task before us is the abolition of the old antagonism between town and country through a new equilibrium between them; true planning is positive and comprehensive. Rightly understood it should lead to the further development of the individual and of his enterprise. Again, conscious "planning" is possible only on a national scale, for only then can each area of the country be brought up to its highest capacity and the systematic

[1] We could talk across continents and oceans, install television sets, travel through the air and beneath the sea, with X-rays we could photograph our insides; yet we could not build our enormous cities so that we could afford a little space where children could play in safety." (Prof. C. E. M. Joad: "Civilization after the War," the "Builder", Dec. 5, 1941, p. 510.)

[2] *Vide* J.T.P.I., March-April, 1941, p. 76.

redistribution of population and settlement be assured. Likewise, flexibility can only be achieved through the co-ordination of the parts on the basis of the larger unit, *i.e.*, national. Flexibility of the social economic structure helps to avoid political difficulties and preserves the essential adaptability of the population as well as of industry and agriculture. This flexibility can only be successful if the plan, in the wide framework of which the future evolution will develop, takes for its goal :

1. A new unity of the structure of the whole population and not just a segregation of its various categories.

2. Freedom from economic crises as far as possible.

3. As a necessary pre-requisite of the realisation of both these aims, a redistribution of the population throughout the country and not only the possible loosening up of a few regions within their own boundaries.

The starting point of reconstruction should be the needs of the population.

" The extraordinary evolution of technique has failed hitherto to take adequately into account the social problem. We have marvelled at the wonders of technique, but have not recognised that these wonders were enslaving men. Let us not deceive ourselves. The change would be enormous if we really tried to get to the root. It would mean the end of " economic man " and the emergence of a new social relationship. The motto of the National Plan should be ' Social Problems first '."

A thorough investigation of the population problem is therefore an essential part of the National Plan, not only in regard to the numbers and age composition, but also in regard to the changes in the distribution of the population itself.

Though some regions may be specialised, in general this is not at all identical with a specialisation of their structure of settlement. The settlement will be, in any case, an industrial agricultural synthesis for rationally developed agriculture in concentrating the population and setting free parts of it for non-agricultural work. And, on the other hand, modern industry is dispersing population and setting free parts of it for non-industrial work.

All this is no more than a general outline of what is involved in the National Plan.

We shall find a better solution for the problems facing us if we recognise that man is first and foremost a social being, and that his social needs should exert a dominating influence in the working out and carrying through of the National Plan.

The Planning Commission

Even in England where town planning has made considerable headway, considerable defects and difficulties are found to exist in the present planning legislation and practice. " Planning is essentially on local basis ; it does not, and was not intended to, influence the geographical distribution of the population as between one locality and another. As the law stands no authority is charged with the duty of considering the local or regional planning schemes in the light of national resources, requirements and interests as a whole."[1]

It is also pointed out that schemes for central areas of cities often provide for an increasing height, coverage and bulk of business and industrial buildings for such areas, while the permitted density of dwellings in such areas in practice follows, rather than obstructs, the centralising tendency. With regard to suburban areas, the view is expressed that while schemes for such areas, set a better standard of density and are effective by zoning methods in preventing an ill-considered jumble of houses and businesses and in securing convenient road lines and often a reasonable provision of local open spaces, etc., they follow in the main the principle of accepting the established tendency.

Present statutory town planning does not concern itself with the larger question of the general and national grouping of population and the task had to be left to a Royal Commission. While local and regional planning schemes may in due course cover all the land of a nation, a national plan conceived as a whole would be likely to differ substantially from a national plan constructed by merely piecing together the local and regional plan. The local and national interests may easily clash. Another difficulty referred to in the case of Great Britain by the Barlow Commission is the absence of reference to agriculture in the Planning Act although conservation of fertile land is a matter of national significance. But

[1] *Vide* J.T.P.I., March–April, 1940, pp. 80–85.

the national aspect of the subject is one with which local planning authorities are clearly not competent to deal.

The creation of a special body is suggested to plan for the nation as a whole whose activity would extend beyond those within the powers of any existing government department. For the immediate work of post-war reconstruction and National Planning defined by Lord Reith falls into three groups.

1. First, the measures necessary to prevent things being done now which would prejudice reconstruction....." wholesale nationalisation " as " not being for the good of agriculture or the country-side." Survey was being made in three heavily damaged test areas—Birmingham, Coventry and Bristol—to show up the legislative and administrative difficulties of planning.

2. The second group is research and information. More can be said about the work of this vastly important section of the Ministry later. The present programme is to include a national resources survey, survey of regionalism, the economics of urban redevelopment and research into building methods and materials. Also of great importance and coming into all groups of work is the question of industrial location which, it will be remembered, was the subject of the pre-war survey undertaken by Sir Montague Barlow's Commission which has provided the nearest thing we have to a " Charter of Planning " for Britain.

3. The last group concerns the system of planning; the examination of defects in the existing system and of administrative machinery.

Only a properly constituted National Planning Commission can hope to deal with these questions. The objectives of this body should be, the re-development of congested urban areas, decentralisation or dispersal of population and industry and the encouragement of a reasonable balance between the different regions and different aspects of production. Even those who differed from the majority laid special emphasis upon

1. " Enquiry and research, devised to lead up to a systematised plan for distribution of industry on a national scale, bringing with it the attainment of a better balance in the distribution of population than now exists.

2. "Pending the evolution of such a national plan, control of changes in the present distribution of industry as, and if, they occur in the ordinary course of business development."

A permanent Board of Research composed of technicians and others as found advisable should carry out research and advise the body. This central Advisory Board must be helped by Boards constituted on a suitable regional basis.

The advisory and non-executive functions of the body must include

1. Collection and co-ordination of information relating to the location of cities, industries, etc.
2. Research and collection of information as to the various natural resources—land, agriculture, amenities, etc.
3. Advice to Government, local authorities, industrialists and others on problems connected with the location of industries, holiday resorts, transport, agriculture and afforestation, grouping of population and housing and provision of centres of economic life.
4. Publicity and annual reports.

An All-India organisation assisted by Provincial Boards should therefore be set up on these lines for controlling the progress of national development with a view to obtain the maximum air security. But this body could also be entrusted with surveys and planning for immediate action to be adopted by the organisation set up for immediate relief. For instance the survey of the neighbourhood of cities to prepare schemes of evacuation, survey of city structures with a view to adopt structural precautions; and this body could also help to obtain uniformity of procedure in different parts of the country.

Different kinds of surveys will form one of their most important functions. Their utility is immense and comprehensive surveys are being carried out even by borough councils in Great Britain. A careful survey has been made by the Islington Borough Council. Both the Government of Great Britain and technical bodies repeatedly recommend it for almost every aspect of A.R.P. The

Home Office points out the need for a survey for ' the location of casualty clearing station, first-aid posts, location of shelters, or precautions for structures.'

As regards casualty clearing stations, a survey of hospital accommodation generally was conducted by the Ministry of Health and the Department of Health for Scotland in co-operation with the Medical Officers of Health. The Home Office insists that it is essential " that consideration of the problem of public shelters should proceed from a careful survey of the accommodation distributed throughout the area and particularly in relation to shopping thoroughfares, which could be made available for members of the public by arrangement with the owners or occupiers of the premises ..... Until such surveys, which might be included in the scheme, are completed, it will be impossible to judge the extent to which special construction should be considered or the parts of the area for which this may prove to be necessary. Authorities are, therefore, recommended to arrange for such a survey to be undertaken."

A survey of city structures in which people have to carry on vital work in war time, combined with maps of danger zones are necessary to furnish information for an economical plan of protection. There are buildings of inferior construction for which protection might prove uneconomic. A survey is necessary to select the worthy ones and determine the type of protection required.

The need for organising and controlling A.R.P. services also require careful survey and mapping of the area. The scheme should be accompanied by a map indicating the situation of first-aid posts, depots and other centres specified in the scheme. It is suggested that for large towns and cities the map should be on a scale of 6 inches to the mile. For rural areas a map on a smaller scale will suffice. The most suitable size should be determined with reference to local conditions and no definite scales could be prescribed, for circumstances vary widely.

A comprehensive survey of the neighbourhood of the cities, the communication and transport systems, water-supply, accommodation and amenities available must be made to prepare plans for evacuation. In fact a million homes in the reception areas were visited and the accommodation studied prior to the great evacuation schemes launched in England at the outbreak of hostilities. To

build temporary camps, to house the evacuees, to provide facilities for food supply, medical aid and education careful investigation is required.

Such a commission will also be of great help to provide valuable schemes and data for effective A.R.P. organisations designed to deal with immediate risks. Adequate material will be provided by the Research and Investigation Department of the National Planning Commission. If this is done, it will smoothen the way to harness even the A.R.P. activities to the long term programme, and in course of time achieve the ideal. The expenditure on A.R.P. will thus contribute towards more permanent resistance and will be of permanent value to the country.

CHAPTER VII

EVACUATION AND DISPERSAL

Chapter VII

EVACUATION AND DISPERSAL

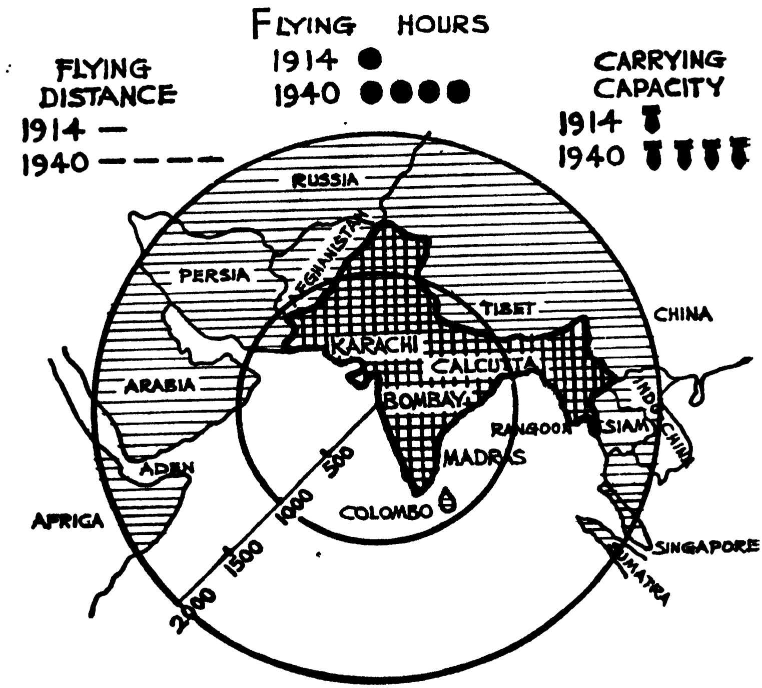
Importance

The reforms suggested in the previous Chapters which would render a nation invulnerable to the air arm would necessarily take a good deal of time. Reshaping existing cities, re-planning the geographical basis of the social economy of a nation and balanced decentralisation of industry would need several years. It has been found that a maximum of only one-sixtieth of the total area of a large town changes every year, to replace existing buildings by entirely new ones, and thirty years if only the older half of them were brought up to date. If this is the case in England where legislation for Civil Defence touches almost every aspect of the nation's life, a longer time must be allowed, for widening the roads, zoning cities and establishing residential estates of the correct type in this country.

The entry of Japan into war and the raids on Rangoon have made it abundantly clear that immediate steps are necessary in this country to resist this danger. The Axis bombers have raided Aden and the possibility of air-craft carriers infesting the sea surrounding the peninsula leaves no room for complacency and measures must be concerted immediately.

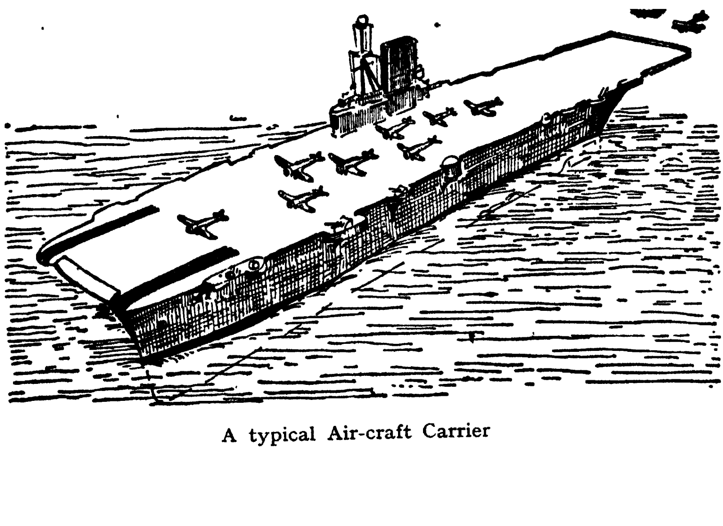
Among the several measures necessary for meeting this emergency evacuation of the civilian population from the vulnerable zones stands foremost. It not merely assures immunity from the risk of air raids to a large section of the population but also reduces considerably the magnitude of the task which the authorities have to meet during a raid. In the words of Herbert Morrison " absence from the scene of danger is the best protection of all."[1] Moreover certain classes of people whose presence is not absolutely essential for resisting air aggression, such as women and children and the sick and the old would complicate and magnify the task of protection if they are to remain in zones liable to raids. No wonder

Vide "Hindu", 4-11-1940.



DEVELOPMENT OF BOMBER 1914–1940

Since 1940, the flying distance, flying hours and carrying capacity have all increased considerably



A typical Air-craft Carrier

that most cities threatened by air arm resorted to evacuation in Europe on the eve of Nazi attack. Even as far back as 1931 a plan for evacuation was prepared in France when Marshal Petain was appointed Inspector-General of Aerial Defence. Warsaw, Helsinki, Oslo and other cities evacuated as many civilian population as possible on the eve of attack. From London and other centres over a million and a half, children, mothers and hospital patients were removed to less vulnerable zones in Great Britain, within a week in September 1939. Nearly half a million school children or about 56 per cent. of the whole school child population in London evacuation area left the Capital. It is stated that nearly one million children have been evacuated from the bombed areas of Germany. Approximately two million inhabitants fled before the entry of German troops into Paris or were evacuated by the French Government. All those who had any vehicle at their disposal left the capital. When Alexandria was bombed about 40,000 people left the city the next day. In India large numbers started evacuation with the Japanese entry into war.

However necessary, mass exodus leads to inconvenience and trouble both to the people and the authorities and unless carefully planned in time, these will be aggravated and lead to hardships and waste of resources. A careful study of the great British experiment would open our eyes to the methods that should be adopted and the difficulties which should be met to render our schemes successful. Considered a marvel of organisation the British scheme has disclosed several drawbacks which we in India will do well to guard against.

The British Experiment

The aim of evacuation is to remove from the more dangerous and congested areas to less dangerous areas of certain groups of people whose removal is desirable on both national and humanitarian grounds. Although this may not save city structures it would reduce risk to life and is indispensable to cities liable to air attack.[1]

[1]The following account is based upon the Home Office circulars, information published in the "Times" London, the "Manchester Guardian," the "Hindu" and the Reports of the Association of Architects, Surveyors and Technical Assistants, the Fabian Society and the A.R.P. Co-ordinating Committee. Also on Robson (*Vide* ante) and A. D. K. Owen, the "Great Evacuation," in the Political Quarterly, January-March, 1940, pp. 30–44.

The classes of persons included in the British Evacuation Scheme are :—

1. School children and the teachers and helpers who would be required to continue the education of the children and to assist in caring for them ;

2. Children of pre-school age accompanied by their mothers or other persons responsible for looking after them.

3. Expectant mothers.

4. Adult blind persons.

The country is divided into areas of three types, sending, receiving, and neutral areas, the last being areas which though not themselves to be evacuated are not regarded as suitable for reception purposes. Evacuation is voluntary. The main source of accommodation in the receiving area is the occupied house. Hutted camps, come next. " Since any plan capable of immediate operation has to be based predominantly on the use of occupied houses, it is to the best methods of utilising this provision, the attention of local authorities have been directed."

The scheme has been planned in great detail. It includes estimates of total population in the different kinds of areas, arrangements in sending areas which cover appointment of evacuation officers, publicity, estimates of the number of persons desiring evacuation, registration of evacuable persons, provision to include teachers, efforts to secure helpers to supervise the children and the necessary arrangements for physically or mentally defective children, children in hospitals, expectant mothers and blind persons ; they also include the necessary arrangements for assembling, transporting and feeding during the process. Arrangements in receiving areas cover the appointment of assistant reception officers, billeting officers, transport beyond detrained stations, billeting arrangements for children accompanied or unaccompanied by other members, registration of evacuated persons, increased supply of food to the areas, arrangements in Post Office for payment etc. ; for education, recreation and equipment of children, for medical nursing provision, for hospital facilities, and welfare work.

Persons who are evacuated should take with them " a gas mask, a change of underclothing, night clothes, house-shoes or

rubber shoes, spare stockings or socks, a tooth brush, comb, towel and handkerchiefs, a warm coat or mackintosh, and packet of food for the day." When a mother is evacuated along with her children or sends another woman to look after them, lodging only will be provided for the adult and for the children. In such cases, therefore, adults should make arrangements where possible to obtain money for their own and the children's maintenance from their husbands or from the parents or guardians of the children concerned.[1]

The Government recognise that a considerable number of evacuated persons will not be able to provide all the articles on the list. No obligation is imposed on the householder to remedy the deficiencies of this kind. The billeting officer will look after this and will provide them by getting money from their parents or from other sources. Adult evacuated persons without means and whose husbands cannot send them money will be financed by the Ministry of Labour. The majority of blind persons evacuated would be in receipt of domiciliary financial assistance, and local authorities of the sending areas would pay them. Medical attendance cost for evacuated children, etc., would be borne by Government and not by the householder.

The Government pays to householders at the rate of 10*s*. 6*d*. a week where one child is taken and 8*s*. 6*d*. a week for each child where more than one child is taken. Payment is made weekly in advance. These payments are intended to cover full board, lodging and all care necessary to give the child a home. The payments are not intended to cover the cost of clothes or medical expenses, which the receiver is under no obligation to meet.

The children bring hand luggage and their gas masks, a change of underclothing, night clothes, house shoes or rubber shoes, spare stockings or socks, a tooth-brush, comb, towel and handkerchiefs, and a warm coat or mackintosh. If a child is without sufficient clothes or some essential piece of equipment, the billeting officer or other local official should be notified.

If the child becomes ill the doctor or the district nurse would be called in the ordinary way and the cost of medical attention will be borne by Government.

[1]Home Office Circular, D. P. Memorandum E.V.S. 3.

Mothers of children under school age may accompany their children. A mother may sometimes send another woman to take her place. The mothers or the women taking the place of mothers will be entirely responsible for looking after the children.

Payments are made at the rate of 5s. a week for each adult or child over 14 and 3s. a week for each child under 14. Payment is made weekly in advance.

These payments cover shelter and access to water and sanitary accommodation and no other services. Cooking facilities may be made available by the householders. The mothers and other adults who come with the younger children would be given an identification form which will enable them if they have no means of their own, to apply for financial assistance at the Ministry of Labour's office. They will, therefore, be in a position to provide themselves with food and other necessaries.

In July, 1938, a Committee of the House of Commons recommended that schemes of evacuation covering the main industrial centres of the country should be worked out and the necessary organisation set up. The September crisis in 1940, however, necessitated an emergency scheme for the evacuation of London school children.

After the emergency had passed, preparations for working out a detailed scheme were resumed at a more leisurely pace. " Evacuation," " neutral " and " reception " areas were defined according to the estimated degree of risk in different parts of the country and plans were made for the transference of certain priority classes—rather more than three million school children, mothers and young children, expectant mothers, and blind and crippled people—from the " evacuation " areas to the " reception " areas. Early in 1939 a detailed survey of accommodation in the reception areas was undertaken with the help of the local authorities and a large army of voluntary workers. As a result of this survey billets for over four million official evacuees were discovered in addition to which it was noted that about a million billets had been earmarked for private evacuation. In response to a widely expressed demand, a modest scheme was introduced for the construction of fifty camps, suitable for holiday and evacuation purposes, by two State-aided non-profit making concerns (The National Camps Corporation in England and Wales and the Scottish Housing Asso-

ciation in Scotland). Detailed arrangements were made for the registration of those who wished to take advantage of the scheme; the distribution of evacuees among the various reception areas etc. "The organisation of the evacuation scheme will probably be recognised as one of the most remarkable achievements of the British Civil Service."

During the opening months of 1940 the daily rate of expenditure on evacuation averaged nearly £36,000 on the British Exchequer. Later the Government bore the full cost of the provision by the local authorities of war-time day nurseries for children under five years, in addition. The cost to the Exchequer of the evacuation of children to safe areas within Britain between the outbreak of war and beginning of June 1940 was as follows. The cost of billeting amounted to nearly ten million pounds, while charges in respect of arrangements for whole schools and special classes for children accounted for just over another million. This was in addition to what the parents incurred. About 53 per cent. of parents were paying full upkeep charges.

Later when defects became apparent additional expense was incurred for welfare work among the evacuated persons. The Ministry of Health started operating 518 social centres, 265 communal feeding centres, 443 occupational clubs, 189 residential nurseries and 130 maternity homes in areas to which the evacuees have been transferred.

In spite of all these, very soon defects became apparent. One writer after four months experience summarised the situation thus. "Husbands have been parted from wives, children from parents. Domestic privacy has been invaded. Urban and rural ways of life have been brought into sharp conflict. Class barriers have been not so much broken down, as ignored, often with heartening, but sometimes with unfortunate results. The education system has been reduced temporarily to a shamble and a great strain has been placed upon local government authorities in areas which have received a great influx of population."

During the first week-end of September 1940, in the shadow of the breaking storm, the great movement took place. The first surprise came early. The numbers coming forward to be evacuated under the official scheme were unexpectedly low. Less than half of those for whom billets had been promised went away.

"Newcastle-on-Tyne sent away 80 per cent. of its school children and Gateshead, across the river, sent away 60 per cent. But two equally vulnerable towns on the East Coast, Sunderland and Middlesborough, sent away only 33 per cent. and 29 per cent. respectively of their evacuable school children. Leeds sent away only 26 per cent. of its school children, Bradford only 31 per cent., and Sheffield (one of the most obvious target areas in the country) a derisory 17 per cent. In the Midlands, Derby sent away 46 per cent. of its "evacuable" school children, but Birmingham evacuated only a quarter of those who were eligible. Of course there was a certain amount of private evacuation outside the official scheme."

This kind of response has been attributed to

1. Uncertainty concerning the financial aspects of evacuation —financial difficulties and fear that a divided household would upset their precariously balanced domestic budgets.

2. Unwillingness of mothers of young children to be separated from their husbands.

3. Inability to pay for clothing to children.

4. The difficulty of separation. 38 per cent. of the parents interviewed by the Liverpool University Investigators in the course of their illuminating survey, gave as a reason for refusing to allow their children to go away, that one or other of the parents could not bear the separation.

At the reception end, barring the minor difficulties of grumbling and occasional refusal owing to wrong delivery, stubbornness of mothers to part from their children, "much more serious problems arose when rural Britain woke up to the fact that the personal hygiene of a considerable section of the urban population of these islands is anything but exemplary." In some places cleansing stations were improvised at central points, after the experience of the first day, but the chief burden fell upon the householders.

Before the end of the first fortnight of evacuation it was evident that a considerable drift home from the reception areas was in progress. The expected air raids had not taken place. The drift back was most noticeable in the case of mothers with young children. Why?

" Even when they were not unhappy in their billets the strain of separation from their husbands, loneliness, nostalgia for familiar sights and sounds, financial anxieties, and a sense of "not belonging" as it was sometimes put, led numbers to return. Unsatisfactory accommodation in outhouses, empty buildings, attics and cellars, resulted in the return of some more, and there were many other cases, where the accommodation itself was excellent, but where incompatibility of temperament and social habits led to friction with the hostess and an eventual break."

A much smaller proportion returned among the unaccompanied children, though in the aggregate their numbers appear considerable. Principally due to the unsettling effects of parents' visits ; failure to understand the terms of the Government proposals for billeting expenses ; unhappiness due to billeting misfits created by difference in social class, religion, etc., and general characteristics of the evacuees and the householders ; absence of institutional provision for the inevitable " problem cases " of all kinds.

"In spite of all the work which has been devoted to it and the sacrifices which have been made, the fact remains that very few mothers, and probably less than a third of the school population of the evacuation areas, are now away from home," wrote an experienced observer before 1940 Christmas and predicted that levels would get lower by the time his article was published.

Day by day the defects of sudden evacuation are becoming apparent. It is expensive to Government ; inconvenient to householders who receive evacuees, and difficult for the family forced to send away the mother or child. The head of the family in vulnerable areas is forced to fend for himself in the absence of the housewife. The break up of the home ideal, has drawn such attention that a deputation of the parents of evacuated mothers protested to Government. The evacuees are not happy in their new homes, as is evidenced from many stories, some amusing and others pathetic, told of them. The early reactions in many cases were favourable to children but soon many have got bored with their new surroundings as expressed by one youngster who after a week on a farm said he " would rather see it on the pictures."[1]

[1] " Illustrated Weekly of India," Jan. 21, 1940, p. 11.

The set-back to education is perhaps the greatest disadvantage to the children of the present generation. " The children who have been evacuated and who are now receiving less than their normal dose of instruction are the most considerable of war victims of England. An investigation lately carried out in Rochdale shows the exact degree of deterioration among children whose school hours have been reduced and the result is sufficiently alarming to make all education committees want to reopen all their schools on a normal full-time basis in the hope that lost ground may be recovered. That wish cannot, however, be fulfilled so long as the Government holds that evacuation is necessary and that children must not be sent back to their homes. In evacuation areas owing to the requisitioning of many schools and the absence of adequate air raid protection for most of the others, more than half the children of school age in these areas have been without normal education since before the summer holidays," and it is matter of deep concern that a whole generation of school children should be suffering such irreparable loss. The dangers of ignorance and indiscipline, it is pointed out are more serious than the risk of being killed or maimed by enemy bomb.

A more serious evil has now been revealed. Heavily bombed industrial areas are said to produce many offenders. Attempts to " divert into useful channels this misplaced energy " are being made.[1] A juvenile crime wave, blamed by psychologists to the war-time lust for adventure is engaging the attention of the British Home Security Ministry. The approved schools are full, there are long waiting lists and court calendars are crowded with juvenile cases. Social workers believe that much of the trouble is caused by the separation of families due to evacuation and bombing fatalities, as well as to lack of parental control in cases where the fathers are in the army and the mothers employed in factories or in civil defence. If war continues for number of years the problem of juvenile crimes would become serious and lack of parental control will do great harm especially in countries like India where it is the home that moulds the young.

Evacuees also bring problems with them to the householders who receive them. Their lot is hard with unacquainted guests, with different tastes and tempers. Some of them are confronted with " verminous slum children who do not know how to eat with knife

[1] *Vide* " Hindu ", 17-8-1941.

and fork and who had the most dreadful parents, who visit them now and then in expensive motor cars." Unsuspected differences between town and country have brought trouble to the householders. Some of them are difficult to feed. Others show no inclination to lend a helping hand in the house even if they happen to be in their twenties and in Government employment. " Worse still they are not punctual at meals, and remember it is an offense against some law or other not to provide these people with a hot evening meal. If the weekly £1 a head which is paid for billetees of this kind covered expenses, much might be forgiven. But it does not. Luckily some of the maiden ladies who have most felt the strain are being permitted to shunt their lodgers to other quarters."

An additional difficulty has arisen from the faulty distribution of food and articles of consumption. Though admirable the scheme of Government for evacuation, " it is difficult for instance to buy China tea in some of the country, though there seems to be no real shortage of it in London. Prices again vary enormously. Country folk buying bacon at 1*s*. 4*d*. a pound exclaim with horror at the idea of Londoners paying a shilling a pound more at some of the West End Stores."

With the rising price level Government payment has become insufficient. " It is proved that the housewife is out of pocket by every child she houses. 8*s*. 6*d*. a head is not enough ; 12 *s*. 6*d*. would be nearer the mark." This is due to the rising price level in the reception area, and the menus to which the family is accustomed for different menus cannot be prepared. The patriotic housewife has not a bed to spare to any relation or friend for a day. The whole woman power of the country-side in reception areas continues to be dissipated and its goodwill discouraged by house to house billeting.

As a result even before winter problems have arisen the London teachers in many areas failed in their objective; thousands of children have been called back by their parents, country children have been frozen out, and the children of the middle and the upper classes have been left as war victims, without educational facilities, and robbed the attention they might expect, from their overworked mothers....“ Many housewives have reached a point of exasperation which is near apathy." Meanwhile they are tied perpetually to their houses, slaving for evacuees, the parents of these evacuees come down on them like bees every week-end in organised " luxury

cruises " of massed relations and friends and are quite prepared to spend £3 on such week-end jaunts, which unsettle their children and lead to entreaties to be allowed to return to London.

Day after day the British press publishes accounts of the many difficulties that crop up in the working of the scheme.

Enquiries and studies carried out by Technical Associations support the prevailing popular feeling.[1] The Special Committee of the Association of Architects, Surveyors and Technical Assistants, the Fabian Society and the A.R.P. Co-ordinating Committee have discovered in dumping strangers from cities into rural household the biggest cause for the failure of the evacuation scheme.

" The greatest single cause of failure is the well-nigh intolerable discomfort and inconvenience caused by the virtually complete reliance on household billeting (camp schools accommodate only 1 per cent. of evacuable school children)" observes the Memorandum submitted by the A.R.P. Co-ordinating Committee to the Minister of Health, to remedy the failure of the Government scheme. For " some 84 per cent. of those whom it was originally proposed to evacuate, are now in the danger areas, and even under the fresh scheme this figure will be in excess of 78 per cent."

Evacuation is thus an evil necessity; " on its personal side evacuation results in the destruction of family life on an unprecedented scale; the separation of parents from children and of husbands from wives. On its commercial side, it leads to an exodus of banks, insurance offices and other undertakings to unsuitable country mansions which must inevitably have detrimental economic consequences. In regard to the dispersal of Government offices it has led to a great outcry from hotel proprietors whose premises have been requisitioned."

A carefully thought out plan should therefore be made to make the scheme effective and minimise the drawbacks. That the scheme should be prepared well in advance needs no saying. During and immediately after a raid it would be practically impossible to move out population. Panic will play havoc especially among the Indian population as it did in Alexandria. About 40,000 people left the city soon after the first raid in June 1941. Numerous special trains had to be run free to any one. The Government had to approve a big credit. Poorer classes were taken free.

[1] A. A. S. T. A. Report on Evacuation. The report of the Fabian Society.

The city presented a remarkable sight with miles of long caravans of evacuating Egyptian families who commandeered every available vehicle piling them high with their bedding, scanty furniture and the ancient, horned gramophones while the less fortunate slowly plodded along the roads leading from the city with bedding and other bundles perched on their heads, carrying children and driving a few miserable goats ahead of them. Whole families of from eight to ten people were crowded into taxis which were almost unobtainable in the town that day for any other purpose. The railway station throughout the day had been an indescribable spectacle of being crowded with literally thousands of Arabs boarding special and ordinary trains on which it was impossible to make any normal reservations. Owing to the structure of native houses which are mostly mud and bricks, bombs caused great havoc, especially as the poorer quarters were extremely congested.

A sudden raid over an unprepared town is bound to cause many difficulties, especially the trouble of panicky people evacuating the area. In Alexandria, the crowds got over the tops of railway carriages in their anxiety to escape bombs and unless the authorities make previous arrangement for extra trains to convey the frightened populace, the task of controlling them would be impracticable.

The Indian Problem

The Far Eastern crisis and the possibility of Calcutta being declared an emergency area, caused a certain section of the Indian population to leave the city. Extra coaches were attached, special trains were run, and the stations were full of passengers proceeding to Orissa and the interior.

The abnormal rise in rent in reception areas around Madras and Calcutta have also become noticeable. Local authorities have been moved by this enormous rise and a conference already was convened in Chingleput. Efforts to control rent similarly have been made by the Hon'ble the Minister for Health in Bengal where centres have been selected to send citizens of Calcutta and others who arrive in the city from Burma. Arrangements for housing them in temporary structures have also been proposed.

In Burma temporary structures were erected in suburban areas or housing the citizens of Rangoon especially those who were

employed in the city so that they could remain outside and work in the city during working hours. Hospital accommodation was also similarly arranged.

Inadequacy of water, drainage and sanitation, the rising price of foodstuffs and other articles of consumption are now coming to prominence in the mofussil centres where people have gone and crowded. The limited housing accommodation and water and sanitary facilities in the smaller towns of India are well known. Even in times of peace they leave much to be desired. Their capacity to absorb extra population is very limited. Suitable measures should be taken in advance and people must be removed from vulnerable zones in time to prevent congestion of traffic after a raid when panicky population will rush out of cities.

Indian cities are as vulnerable to air raids as any other. The destructive consequences would in no way be less than what they were in the cities of the West. Although statistics show the average density to be thirty-nine homes per square mile and five persons per house, certain urban areas are extremely congested. Japanese raids over the cities of Burma and Malaya have shown that destruction to people and structures is possible.

The lay-out and the physical features of towns and even large villages are very helpful to air attacks. Dwellings are clustered together, packed closely with little space around each dwelling. A number of such narrow strips surrounded by pastures form the village while many more such streets form a town. Detached houses surrounded by garden as found in parts of the West Coast in Malabar and Travancore, and in rural Bengal and Assam form a very small proportion of India's houses. Both Indian towns and villages are extremely vulnerable to incendiary bombs, gas and the high explosive. If Spanish experience should guide us (towns of 10,000 inhabitants were not spared) over 10 per cent. of India's population need protection against air raids. The table on page 241 showing the distribution of India's population according to the size of villages and towns would indicate the number of centres and population liable to danger.

For the present we could leave out of account those residing in villages of less than 5,000 inhabitants; those who dwell in those between 5,000 and 10,000 might be harassed by machine-gunning,

Towns and Villages classified by Population

Size		No.	Population
1. Under 500	..	509,786	97,516,496
2. 500 to 1,000	..	113,541	79,189,377
3. 1,000 to 2,000	..	53,908	73,707,758
4. 2,000 to 5,000	..	18,836	53,556,566
5. 5,000 to 10,000	..	2,330	15,412,217
6. 10,000 to 20,000	..	632	8,537,719
7. 20,000 to 50,000	..	269	7,940,572
8. 50,000 to 100,000	..	66	4,566,885
9. 100,000 and over	..	38	9,640,132
		699,406	350,558,841

(Census of India, 1931, Vol. I, Part II)

India (including States)

Area in Sq. miles = 1,808,679

	No.	Occupied houses	Population
Towns	2,575	7,935,898	38,985,427
Villages	696,831	63,126,239	313,852,351
Total	699,406	71,062,228	352,837,778

anti-personnel and incendiary bombs by low-flying air-craft; those who live in centres where more than 10,000 dwell, definitely need A.R.P. measures, while the inhabitants of 38 cities with 100,000 and over should come in for special consideration. In other words 30 million people need protection from air attack in our country. Although arbitrary this grouping would help to show the intensity of the problem in India.

Average densities are not of great practical value for this vast country with varying conditions and features. As the Census Commissioner remarks "the indeterminate nature of the village unit, which may be a definite residential site, walled or palisaded or, may be an administrative unit containing several residential villages or a number of scattered houses, impairs the significance of the figures of the population as distributed in villages of various sizes." Averages for India reveal the following figures:—

Census	Persons per House	Homes per Sq. Mile
1901 ..	5.2	31.6
1911 ..	4.9	35.8
1921 ..	4.9	36.1
1931 ..	5.0	39.3

(Census of India, 1931, Vol. I., Part II, p. 55)

The house for census purposes is "any part of an inhabited building with a separate entrance." And averages per house and houses per acre cannot reflect the situation for one building may contain many homes and families. Overcrowding is extremely vulnerable to air raids and parts of Indian cities are very congested as the following table would show :—

City	Ward or Division	Extent acres	Density per acre
Bombay ..	Kumbharwada	44	727
	2nd Nagpada	33	636
	Kathipura	62	602
	Khara Talao	41	565
Calcutta	Kumartuli	27	226
	Kalutola	45	219
	Puthapukur	32	213
Madras ..	Municipal Division No. 9	67	250
	,, 25	88	228
	,, 34	89	193
	,, 13	149	183

Housing Congestion in Bombay

Number of Rooms per Tenement	Number of Tenements	Average per room
1	197,516	4.01
2	26,231	2.51
3	7,416	2.01
4	6,169	1.70
5	2,953	1.50
6 and over	3,836	—

The position in India is not less grave than it is in Western Europe. In fact important areas in our large cities are more

vulnerable to air raids than some of the most dangerous spots of urban Britain. Town Planning laws have done something to secure a minimum proportion of open space to built-up areas, etc., whose counterpart we do not find in India.

The task ahead is, therefore, vast and planning of evacuation schemes should be done in advance and the superfluous population removed to suitable areas as early as possible. In this matter we have to make provision to meet the defects disclosed by the working of the English experiment.

Suitable centres should be selected not very far from the evacuation areas for conversion into reception areas. Transport facilities, water-supply and sanitary conveniences should be taken into consideration. Existing housing accommodation should be investigated with a view to discover how much extra population could be housed.

Medical aid, police staff for preserving law and order, agencies for distributing essential foodstuffs and other articles should be provided. Educational facilities and recreation are also necessary to break the monotony of the new environment.

The need for all these would be clear from the recent activities regarding evacuation schemes in Great Britain. Several social welfare centres have been opened in the reception areas and nursery centres, no fewer than 86, were erected in May 1941. With the evacuation of many thousands of small children from large cities an urgent need arose in the reception areas for nursery centres. The Board of Education and the Ministry of Health jointly advocated the idea of nursery centres in January 1940, the nursery centre being described as "something between a day nursery and a nursery school" and as "the type of provision which seems best calculated to meet the children's needs in the present exceptional circumstances." Such buildings were eligible for a 100 per cent. Government grant for upkeep and maintenance. Eighty-six such were in the course of erection in May 1941 and provision was made for more. Nursery groups providing for from 10 to 20 children may be accommodated in single empty rooms in houses or other premises. The need for decoration of interior wall has been emphasised.[1] Furniture, educational apparatus and toys are all needed and could be easily made by voluntary method.

[1] H. V. Lanchester, "Nursery Centre Equipment: An Economical Programme."

The first Nursery Centre to be opened was at Guildford on April 26, 1941, by Mr. Herbert Morrison.[1]

The building is an adaptation in plan of the Army hut standard. The plan includes two playrooms 20 feet by 20 feet, a small bed-store and staff room, together with lavatories and cloak-room, giving accommodation for 50 children, superintended by four teachers.

The form of construction chosen was that of the prefabrication standard unit developed by Messrs. Gyproc Products Ltd., on a concrete raft, a framework of 5 inches by 5 inches reinforced concrete stanchions with light steel roof trusses were set up, to which were fitted factory-made panels of two outer thicknesses of three-fourth inch Gyproc on a light frame of timber. The external face of the panel is covered with one-ply roofing felt and the joints are caulked with mastic. Wall panels and roof panels are identical, and the actual erection of the hut can be carried out in less than three days once the site work and the raft has been laid. The internal plumbing, erection of partitions and decoration can be completed in under a fortnight. If no difficulties in respect of weather, labour and organisation arise, the emergency nursery centre could be completed in under five weeks.

When the need for staying permanently in the reception areas due to continued Blitz arose, it became "increasingly apparent that the conditions under which people are evacuated or received are not adequate if they give no more than sleeping accommodation." Mothers are anxious to place their children in schools and to prevent adding more numbers to the swarm of shop gazers in reception areas.

The other vital question is the provision of adequate housing accommodation for the evacuees. In England where preliminary investigation revealed the existence of facilities to accommodate some millions, it was discovered that they were found inadequate and this inadequacy contributed largely to the failure of voluntary dispersal.

A leading Indian daily has already drawn attention to the benefits of such a scheme. It has suggested rural holidays for urban children, so that those likely to be evacuated could familiarise themselves with new conditions under which they will have to live during emergencies. The health of urban children will also much improve

[1] *Vide* "Builder", May 23, 1941, p. 499.

by such periodic changes, and the difficulty such rural holidays would entail would be far less here than in Great Britain owing to our economic and social organisation, joint family system, kinship, etc.

Housing in Indian villages is deplorably inadequate even to meet the demand of the villagers in normal times and it can never accommodate extra population accustomed to life in cities. Even in Great Britain where accommodation in private homes was available for five million people according to surveys carried out before the great evacuation, technical authorities and the press have made out a strong case for billeting camps and permanent structures if evacuation should be successful. The Committee of the Association of Architects, Surveyors and Technical Assistants who studied this problem draws attention to the fact that permanent camps could be erected for the same expense that the Government might incur on paying billeting charges to householders.

Evacuation and Rural Betterment

The report shows that on the assumption that the war will last for three years, the Exchequer will spend more than £60 in that time on the weekly payments for lodging (excluding food) for a mother with her child. The report states that for a little more than this sum they could be provided with a place in a new building designed for them.[1] Their comprehensive survey of Wantage and eleven surrounding villages in Berkshire made twelve weeks after evacuation took place, presents an overwhelming case for the creation of special buildings for evacuation including camp schools, new buildings for education and feeding, nursery schools and day nurseries. They are considered absolutely essential on health, education and moral grounds and their absence is considered the cause for the collapse of the scheme, particularly regarding mothers and children.[2]

[1] A.A.S.T.A. Report on Evacuation. The "Builder", Oct. 20, 1939, p. 596.

[2] The question of Evacuation camps is receiving the attention of designers, social workers and architects. For plans and details refer: R. C. Butler, "Billeting Accommodation", "Builder," Nov. 3, 1939, pp. 641–646 and Nov. 10 and 17, 1939; Goldfinger, Mary Crowly and Anne Parker, "Builder," Oct. 27, 1939, pp. 615–616; W. H. Hamlyn, "Prestatyn Holiday Camp", "Builder," June 30, 1939, p. 1234; Frank Bennett, Children's Large Scale Camps, "Builder," April 7, 1939, pp. 654–656; The Planning and Design of National Camps, The "Builder," Aug. 11, 1939, pp. 233–238.

These structures would not become valueless after the war, like other defence constructional measures, but could serve a great social and educational need in that town children could in summer spend part of their term time in these fully equipped camps. A part of the capital cost could be recouped through individual local authorities taking over one or more camps for the use of the children of their areas. The example of a London Borough which has already commissioned the design of a holiday centre on the Kent coast is mentioned. Far greater is the other advantage. In their own words:

Evacuation camps erected near London

" There are no short-cuts to successful evacuation. A programme such as we have outlined gives us a chance to end that lack of sympathy between town and country which the present scheme has exposed. We can enrich rural life and at the same time broaden that of the town. We can keep our children in safety by measures of defence that will not only protect from attack, but will give lasting benefits when the war is over."

The Fabian Society which examined the problems raised by this great migration in an impartial manner feels " the early stage of improvisation must merge into the stage where evacuation can be made a complete success ; in other words, the social pattern of the country-side has to be re-fashioned in a relatively stable direction." Their emphasis upon the value of permanent buildings to rural betterment is interesting.

" A well-designed experiment in social reform would leave the country a heritage of camp schools, village halls and clubs, nursery, hostels and the like, such as it had never before enjoyed. Permanent links could be established between urban and rural communities ; a sense of the values of right feeding, of air and sunshine, of child nurture and of social enterprise could be carried to half the homes of Britain."

The need for permanent structures and holiday camps is so much felt that even an exhibition of plans and models of evacuation camps for families and a village settlement for mothers and infants, a rural centre for young children with class rooms and dormitory was recently held in London. These plans are of interest to India for they suggest how the problem might be solved especially when husbands remain in cities, by small communities of the scale of family groups, with privacy as well as such social amenities as necessary. These could be planned near existing villages or market towns. The structures, it is considered, should be of such a character and quality as to be of service and permanent value in times of peace as well as war.

The adaptation of existing buildings in rural areas was examined by a well-known Committee who finds that "while much can be done by adapting existing buildings, a considerable constructional programme is required." Although considerable sums would be required it is considered it would be economic.

"The complete programme would employ some 150,000 of them for eighteen months or two years, and would cost about £104,000,000. That the expenditure is quite in proportion to the importance of the matter is apparent if one realises that the capital cost, if repayment were spread over two years, would add less than 6*d*. to each £1 at present being spent on the war. Further, the measures undertaken would bequeath a valuable legacy to peacetime England."

The Government of Great Britain is also convinced of the value of permanent structures as proved by their scheme of National Camps. Thirty-one Camps were being built by the National Camps Corporation at the beginning of 1941. Camp managers were appointed for 25. Two were occupied by the end of January.

Considerable economies and a healthy national growth would become possible if these structures in villages were used for securing permanent decentralisation of population and industrial production. This would end to a large extent the need for evacuation whenever national security is endangered. Evacuation cannot be a permanent part of our life as Principal Rowse pointed out in one of his recent addresses.

" Is it to be the background against which our younger generations will grow up? If so, is it not time that human beings, thus wrenched from their habitat, are given shelter, in a psychological as well as physical sense, from the overwhelming dread of the bombing planes of Eastern Europe? That sense of shelter can only be had when the technique of dispersal followed does not involve the breaking up of families, but ensures in an orderly manner the transfer of homes, nay whole communities, with social services, industries and the means of leisure, to the safer zones throughout the country."

The need for permanent decentralisation is being forcibly urged by Town Planners. The uncontrolled growth of cities was being viewed with disfavour during the last many years which culminated in the appointment of the Royal Commission, four and a half years ago whose terms of reference emphasise the " social, economic or strategical disadvantages " arising from the concentration of industry and population in large towns or in particular areas. All the members agree " the objects of national action should be the continued redevelopment of congested urban areas and decentralisation or dispersal of industries and industrial populations therefrom and the encouragement of a reasonable balance in development." After surveying exhaustively the social, economic and strategical effects of population movements in the post-war period and also their causes the members emphasise the need for decentralisation.

A strong case has been made out for permanent decentralisation even if it were possible to organise programmes of evacuation with success. A peace-time use has been pointed out as the strongest case for permanent structures but the arguments adduced by the Council for the Preservation of Rural England possess special value for India where ordered movement for the dispersal of towns could be harnessed to the task of village betterment so much desired in this country.

The need for dispersing the town population in India over the neighbourhood to create living links between rural and urban parts and encourage flow of men and ideas would become apparent when we analyse carefully, the causes of India's poverty and low standard of living.

It is now realised that the first factor responsible for India's poverty is the continuous drain of money and resources from the rural to the urban area. Year after year crores of rupees are brought to the treasury in the shape of land revenue, remitted to students for university education, sent to creditors as interest and principal, and more crores are taken away by the absentee landlords for spending in towns. Every one knows that over 75 per cent. of our university students are drawn from the rural area, and that cities and towns form the financing centres to the surrounding area. Several factors have tended to make absentee landlordism a universal phenomenon, and if the ryot does not migrate to towns, the townsman is ready to purchase lands from neighbouring villages. Finally, we may mention lawyers and law courts that draw out the villager's wealth. That the sum total of all these is considerable nobody can deny though it is impossible to estimate the total, accurately.

The second factor is the constant drain of men—the powerful and intelligent—from the rural to the urban parts. The enterprising poor are forced to leave the village for a livelihood, and the idle rich are lured away by urban pleasures and city comforts. The huge gulf between our urban and rural standards of living, the enormous disparity between agricultural earnings and income from employment and service (till recently) has tended to drive many a potential leader of the village away from home. Thus, men whose stay in the village would have checked the pace of deterioration, whose initiative and enterprise would have improved the conditions of living are almost lost to the village.

These two factors constitute a " net drain " upon our rural economy. Very little is put back into the village; all that goes back being the salaries of the village officers and servants, and the touring officers of the district, and a part of the public works expenditure that goes towards the wages of labour, etc., and the price paid for food grains by 10 per cent. of the population which is urban. Highly paid officials, and even retired officials, rarely stay in villages, and a very large part of the total State expenditure is incurred in the urban areas.

The break-down in the self-sufficiency of the village has only facilitated the " drain " from the country to the town, and has overburdened our agriculture and created unemployment for the

artisan classes and industrial communities and upset the balance between agricultural and manufacturing industry. The other factor is the colossal indifference and apathy of the public towards rural problems in general. It required a disastrous fall in agricultural prices and a catastrophic depression to focus public attention on the need for rural reconstruction in a country where 90 per cent. of the population live in villages. The indifference of the so-called enlightened urban public which is largely responsible for the stagnation of the rural uplift movement in India can be got over successfully only by bringing them in touch with rural folks and problems. And a balanced dispersal not merely from cities to townships but from tiny villages to larger ones is required to restore the correct balance between agriculture and industry and the town and country. This will provide the basis over which a prosperous India could be built.

How can schemes for evacuation and decentralisation help rural reconstruction? The inter-connection between rural poverty and urban apathy to problems connected with ameliorating such conditions would become apparent when we realise that this is largely due to the constant drain of men, money and enterprise from rural to urban areas. If village India is not able to succeed in resisting gradual impoverishment overpowering her, there are not sufficient men and resources left to evolve schemes to check it. Improvement is possible if enterprise and resources are directed from urban to rural centres, if enlightened interest in rural welfare is made possible to those responsible for governing the country who generally reside in towns and if frequent contact is maintained between the two.

Holiday camps and week-end resorts would serve this purpose admirably. They may serve as evacuation camps for those who must remain in towns, until air raid-proof cities come into existence; they would also serve to enrich the country-side with urban resources and earnings. Many attractive places abound all over the country which would serve as welcome resorts to the overstrained citizens. This is vitally necessary to improve the health of urban folk. If English evacuation teaches us a lesson it is this. Children in reception areas are now found to be healthier than when they came. The improvement is considerable. They are able to withstand hardships better.

Even in Great Britain it is now felt that a ladder back to the land which shall surmount the artificial barrier that at present divides town and country is necessary. A recent author (G. Goddard Watts: An Agricultural Policy for Britain) condemns "the inverted snobbery of an educational system that thinks only in urban terms and regards an urban calling as the natural goal of the bright boys in the school." The land wants the bright boys, and the problem is, in Mr. Watt's opinion, a simple one of education and apprenticeship, requiring as a solid background improvements in wage rates, increased opportunity, better rural housing and modern amenities. Here the architect and planner comes into the picture, for the success of the scheme largely depends on formulation of a policy and the laying of a plan now, before peace overwhelms us. Conjoint with the steps outlined would be educational and propaganda drives to unite the farmers and win over the townsman (and especially the "hard core" of industrialists) to what is, in effect, a reversal of British economic policy.[1]

A proper road system and communication and transport facilities would make this practicable. The development of electric power will make the decentralisation of industry feasible. These two would pave the way for more extensive decentralisation and " hundred new towns " ideal preached for England would materialise in India. These would form the nucleus wherefrom the movement for village betterment would draw sustenance and rural improvement would become practical and successful. A permanent basis to build India's prosperity could be secured by this balanced dispersal which would avoid the dangers to which the excessively urbanised industrial civilisation of Europe is exposed.

Indeed a balanced dispersal not merely from cities but from very small villages to larger ones is essential to restore the correct balance between industry and agriculture, town and country, urban and rural interest.

This will be difficult if not impossible if India gets industrialised on the lines of England. Attempts are made in Europe to decentralise production over the nation and such expenses could be avoided by adopting this step in advance. Widely distributed centres of industrial production are necessary to this vast agricultural country to minimise the cost of transport as well as to help the development of local tastes and requirements.

[1] *Vide* the "Builder", August 1941, p. 107.

Various forms have been suggested for camps in the West. Prefabricated materials are recommended. Temporary makeshifts in furniture and equipment are considered. School camps with dormitories, common dining rooms, facilities for study, etc., are suggested as a very desirable ideal, for, this would help urban children to live in rural areas during holidays and recoup their health. The improvement in physique of children in the reception areas of Great Britain proves their value.

The planning and design of National Camps is being given great attention by experts in England and designs suitable for camouflaging the entire area are recommended. They are nothing less than small towns of peculiar design specifically laid out for the collective entertainment and fair-weather accommodation of thousands.

To India permanent decentralisation is to be preferred and immediate steps must be taken to survey the country and select suitable sites for locating her industries and townships. Seaside resorts, pilgrim centres, marketing places and healthy areas fit for sanatoria should form a network wherein permanent structures built of local materials would provide for evacuation if need be. In peace time they would form community centres and house the local rural uplift branch. After some years this centre will develop into a township.

Spacious halls with verandahs, with rooms in the form of a quadrangle and vegetable gardens, poultry farms, tanks and playgrounds as also accommodation for cooking for holiday makers would be essential. A school for the children of the surrounding area would also be helpful. But provision must be made for facilitating periodic demonstration and shows to bring home to the residents of the region, improvements and ideas in different aspects of life. These holiday camps properly designed and located would be economic and paying. These centres might send supplies to the neighbouring city. Handicrafts and small scale industries could be developed. The development of electric power in our country will help the progress of small industry and properly guided would prevent the tragic growth of industry and slums now facing Great Britain.

This is perhaps the best method of arresting the drain from country to town already noted and these centres might even now be selected and the accommodation surveyed to prepare camps for temporary schemes of evacuation for emergency. The war clouds have sufficiently gathered to make this task imperative and immediate plans must be made to minimise destruction. The level country surrounding the Indian cities is helpful and places must be found to evacuate citizens and their belongings in emergency.

This plan for evacuation should in the interest of the country constitute a temporary phase and never replace the scheme for permanent decentralisation and the prevention of excessive urban expansion.

Housing the Bombed-out

Provision of housing around vulnerable areas for those who might be bombed out of their homes and whose presence in the city is essential to maintain the normal life of the region is equally vital. Many would be rendered homeless by raids and unless they are housed and fed they may run away, causing a break-down in the maintenance of essential services. Even otherwise they would be subjected to excessive hardships and it is only fair to look after their comforts.

Air raids have rendered thousands homeless in Bristol, Southampton, Plymouth, London, etc. Empty houses in the West End of London were utilised to house many London families bombed out of their homes and who were not willing to leave the capital. In the earlier days of the Blitz Government did not provide for this factor which invited bitter criticism in the Press.

As Mr. Kingsley Martin put it in the *New Statesman and Nation* the Government miscalculated the nature of the war.

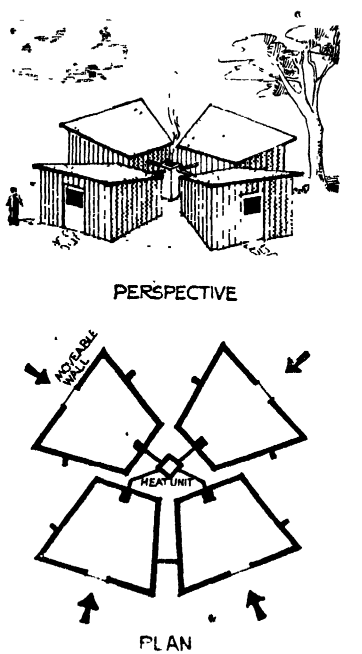
" Everything was done," he says, " to prepare for death and injury. Tens of thousands of papier mache coffins were ready; excellent hospital arrangements were made; first class ambulance and nursing arrangements were ready. But no thought had been taken for the living and uninjured homeless." The homeless were allowed to drift and such thronging of the civilians might have created panic and confusion, so fatal for morale, but for the tireless work

of volunteer workers, particularly the clergy and doctors of the East End.

The dislocation of domestic life and the changes in social habits due to the raids are also tremendous. Sleep is most important for the human system, and its interruption due to raids necessitates people snatching a nap whenever possible.

The Ministry of Works have, therefore, built hutment camps outside London for bombed-out civilians. Homeless people live in them until their houses have received "first aid" repair, or until they can get to friends or relatives or be billeted. They are built on the fringes of certain towns liable to enemy attack as temporary rest centres for bombed-out civilians, and some in cities also.

Made in sections, the huts are long low structures of standard pattern designed for rapid erection.



Camps suitable for erection around Indian cities for housing the bombed-out

Each hut will provide accommodation for 32 single persons or be divided into compartments for married or family quarters.

Essential furniture equipment and sleeping bunks will be provided. There will be a communal dining room on each site, and cooking will be done in a central cook-house.

There will be medical and other attendants on each site.

Camps are not for permanent residence, but supplement the rest centre system.

Homeless people live in them until their houses have received "first aid" repair, or until they can get to friends or relatives or be billeted.

Such camps are needed around Indian cities for dispersing the essential city population as well as for those bombed out. A suitable design is shown and might be adopted for it is quickly erected from local material. Hospital accommodation is also necessary away from cities, as experience has shown in Rangoon.

Decongestion

Equally urgent is the third aspect of this question, namely, the decongestion of overcrowded centres in vulnerable cities, and the removal of people residing around obvious targets at least to the outskirts of cities. Slum clearance assumes a new significance for they will contribute most to the destruction and panic when there is a raid. Indeed air raids are a challenge to slums, to inadequacy of our street systems and our neglect of the requirements of planning and healthful living. A policy immediately launched would provide the basis for reshaping our cities on the model suggested in Chapter VI. The provision of facilities for transport, water-supply and policing would make this decongestion possible and practicable. Even slum clearance in the accepted sense of the term will not cost more than what will have to be incurred on A.R.P. for the slum areas, together with the recurring expenditure on civic services maintained to prevent its dangerous consequences to the civic organism.

A scheme for permanent decentralisation and regrouping of population and industry, plans for holiday camps and week-end resorts and evacuation and a programme for decongestion should be made if the destruction from air raids should be minimised and ultimately prevented. The problem in India is less expensive than in European countries but not less urgent. This is further necessary to make possible the provision of shelters and protective accommodation in cities. Without these measures not merely shelter provision would prove inadequate but impossible.

CHAPTER VIII

AIR RAID SHELTERS

CHAPTER VIII

AIR RAID SHELTERS

To those who must stay in vulnerable areas, measures to protect their person from injury and death caused by air-craft bombs and their consequences are necessary. In an emergency it is difficult, almost impossible to provide all the population with accommodation ensuring absolute safety, such as those described in Chapter III. Since direct hits are very few, measures to safeguard the citizens from blast and splinters, demolition of structures and anti-aircraft shell shrapnel alone, are considered practicable and sufficient. Air raid shelters, as such protective accommodations are styled, have been provided in almost every city where air attack is anticipated. They are found in China, Malaya, India, Turkey, Germany, France, Switzerland, etc. and Great Britain.

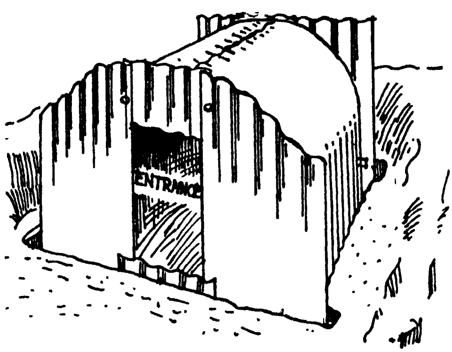
Millions of pounds have been spent on the Continent of Europe and in Great Britain on air raid shelters. Seventymillion sterling was allotted for civil defence during the financial year 1939-40, in Great Britain and during the first half of the year 1939 " nine hundred thousand steel air raid shelters capable of efficiently sheltering nearly five and a half million people " were supplied, free to householders in vulnerable areas whose income did not exceed £250 per annum. Employers have also been compelled to provide shelter protection to their employees. Thus the majority of urban inhabitants of Great Britain have air raid shelters.

Many kinds of shelters have been erected and existing accommodation wherever suitable is also strengthened and converted into shelters. Some of them are within a building, some outside and independent. Some are overground, some deep underground. Brick, cement and steel are used and even timber has its place in their construction or conversion. They are large, medium or small in size ; small shelters are for families ; medium size ones are for commercial and business premises ; large shelters are designed for factories, floating population and large communities ; shelters for key men are perhaps the smallest. The small shelter is recommended for families for access and proximity. The Home Office

of Great Britain, relies largely upon this feature. Large shelters are preferred for efficiency and economy. Medium shelters are ideally suited for offices and commercial concerns.

Domestic Shelters

Great Britain relies upon the small steel shelter to 'break the back of the shelter problem.' Popularly known as the Anderson Steel Shelter this is distributed free to householders with incomes not exceeding 250 pounds a year. This is to be installed in the garden, sunk three feet in the ground and covered with earth and sand-bags. Blast and splinter-proof to 500 pounds high explosive bombs exploding not nearer than 50 feet it is regarded as the most practicable solution for safeguarding the people.[1]



Anderson Steel Shelter set in position ready to be covered by earth

The shelters are constructed of very strong galvanised corrugated steel sheets and have been subjected to rigorous tests to ensure that their strength when erected would take the weight of any debris that might fall upon them from a house of the type for which they are designed.[2]

They are made in sections and can be put together by two persons without any special skill or experience. They will be supplied as units of dimensions of approximately 6 ft. 6 in. by 4 ft. 6 in.

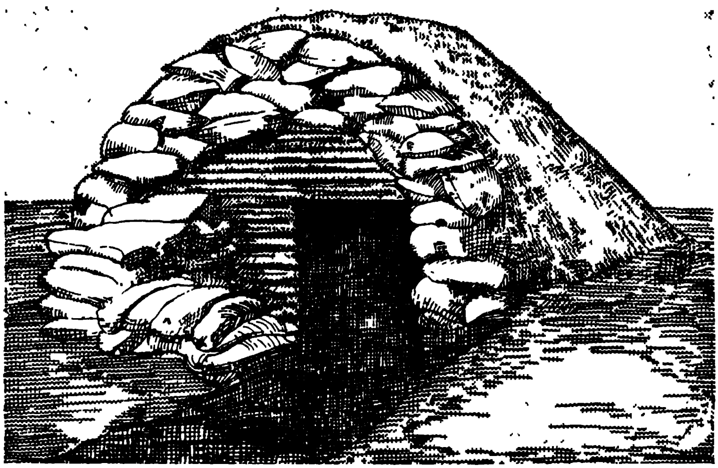
[1] These shelters are distributed free to the following :

1. Persons whose occupations are compulsorily insurable under the National Health Insurance Act.
2. Persons not compulsorily insured under the National Health Insurance Act, who are mainly dependent on earnings (or pension) not exceeding £250.

This amount would be increased by £50 for each child of school age in excess of two.

[2] *Vide* A.R.P. Dept. Circ., January 9, 1939, "Provision of Air Raid Shelter", pp. 13–18.

by 6 ft. high, the completed unit weighing about 8 cwts. A unit shelter of these dimensions will provide shelter for from four to six persons, and sections can be added to take more persons if there are more members in the household.



The Anderson Steel Shelter

While the unit is provided with channels which enable it to rest on the ground, it is designed for being partly sunk and for the earth excavated to be used as additional cover to make the shelter more secure against blast and splinters.

The shelter, as supplied would accommodate from four to six persons, and when sections are added to this unit may take two or four more persons.

The maximum number of persons that can be accommodated in the standard shelter with extensions, is ten. If it is desired to accommodate more than ten persons, two shelters of appropriate size should be erected.

The standard shelter with the extensions may be used for houses of three or even four storeys if it is possible to site the shelter at a distance from the house or any neighbouring building of at least half the height of the nearest wall of the house or other building. Where that distance exceeds 15 feet an earthen or other wall should be erected to provide splinter-proof protection for the shelter entrance.

Generally they are suitable for houses of not more than two storeys with a space large enough to enable the shelter to be sunk, of the type normally occupied by insured persons.

It has saved the lives of thousands of people. There are many cases where bombs have fallen almost a few feet away from such shelters, the inhabitants of which have escaped unhurt although in many cases dazed by concussion.[1]

Bunks should be provided in Anderson Shelters for sleeping purposes. Some Londoners have installed four bunks for adults, each 6 ft. 6 in. in length and across the two, smaller bunks for children. They are 20 inches wide and leave room for a 14-inch gangway and solve the problem of staying within during nights.

It has been found that it is not possible to erect this for every home. Flooding is a risk to which this is liable. The Lord Privy Seal recognised "a spell of wet weather" may produce trouble and special instructions have been given by government. Measures are suggested for shelters already erected and where they have not been erected it is considered expedient to construct a 4-inch concrete, or one-course brick floor in the shelter ; or lining of the actual sump excavation with timber boarding or brick, or concrete, whether precast or *in situ* ; and the lining of the inner walls of the shelter, up to ground level. This may entail an extra cost ranging from

[1] The violent and very extensive raids by the *Luftwaffe* in the week ending August 17 provided a most reassuring demonstration of the efficacy of the Anderson Shelter, when it has been properly covered with earth and the entrance adequately screened. Both at Croydon and in the Midlands its value was proved. When a bomb dropped in the middle of a triangle formed of three Anderson shelters in a Midlands town, the occupants of all escaped unhurt. Seven people taking cover in a home-made shelter, however, were killed. Seven persons sheltering in an Anderson shelter in another Midlands area were unharmed by a bomb which exploded immediately outside it. When sixteen Nazi bombers were caught at Tilbury (Essex) between the A.A. Barrage and " Spitfires " they scattered and fled to sea with a vicious pursuit encouraging them. Six of their bombs fell on a housing estate. Four exploded harmlessly on grass verges, and two blew out the sides of a council house, but the occupants were in their Anderson Shelter, less than ten yards away, and were unhurt. One man in South London, with his wife and two children who had been evacuated from Folkestone, said that they were in an Anderson Shelter during the raid on August 18 when five bombs fell within a distance of 100 yards. " Our little shelter trembled," he said, " but we suffered no shock and no damage, though our windows were broken." On the other hand, people in an Anderson Shelter in the South-Western suburbs were injured by bomb splinters penetrating the back of the shelter, which was not completely covered with earth. *The Illustrated London News*, August 24, 1940, p. 232.

£1 5*s.* to £3 13*s.* The cost of a steel shelter is about £8 according to manufacturers.

Many Anderson Shelters have been abandoned by the public and local authorities since they found it impossible to make them waterproof. The result of a survey carried out by the Ministry, however, showed that methods previously advocated for dealing with these problems can be effective if carried out honestly and with care. In a later Circular No. 96—1941 the Ministry of Home Security made further recommendations for drainage, concrete, tanking, construction of sumps, floors and a method of clay puddling to seal joints.

Experiments have been made in Birmingham by the City Engineer and Surveyor with the building of Anderson Shelters inside the living rooms of small houses.[1]

If an Anderson Shelter is erected in a living room, it has to be bolted down to the floor and strutted with timber so as to be rigid enough to withstand, without collapse, the fall of the house in case this should occur. Although inconvenient in the average living-room, it is still possible in many cases to use the remaining portion of the room for meals and other domestic purposes.

In a household where not more than four people would require to sleep in the shelter it is quite reasonable to establish a normal living-room in one of the present bedrooms and to turn the down-stairs living-room into a dormitory. This is not entirely convenient because the existing living-room usually contains the cooking stove, cupboards and other amenities, but an upstairs room can be used just as well as a sitting-room as one on the ground-floor.

When an Anderson Shelter is placed in the living-room it is usually necessary to build a blast wall outside the living-room window because the protection of an earth covering over the shelter cannot, of course, be supplied. When this is done, the people sleeping in the shelter should be reasonably secure from splinters, from injury due to collapse of the house, and from falling shrapnel or debris which usually will not penetrate through the floor of the upstairs rooms.

[1] J.I.M.Cy.E., Vol. LXVII, No. 9, pp. XX—XXIV.

The help which is being given by the Birmingham Public Works Department to those wishing to take advantage of this experiment by having their Anderson Shelter erected in their house consists of advice, the timber and other materials necessary for strutting and, if available, the concrete blocks for building a blast wall. The Public Works Department are only in a position to carry out the work for a very limited number of persons who cannot do it themselves. Wherever possible, householders are urged to try to carry out the conversion themselves. Assistance by the Department must be limited to those cases where the Anderson Shelter at present is quite unusable owing to its being continuously waterlogged and where, in addition, there is no man in the house.

To facilitate erection, the Department has prepared explanatory notes and sketches. It is pointed out that the shelter should be erected with one side close to a 9-inch wall and the side which is not supported by a wall must then be well strutted, to prevent it collapsing, under the debris load if the house is damaged. The two ends are tied together with steel rods which will be supplied.

As the steel shelter gives no protection against bomb splinters, it is essential that any door and window openings not masked by another wall within 15 feet distance, should be screened by a wall of brick or concrete blocks filled with sand, boxes of earth or other suitable material. The top of the wall should be at least above the level of the head of a person sitting in the shelter. The entrance to the shelter can be altered to floor level by raising the small corrugated sheet and fixing it in the position of the present opening.

The materials which the Corporation supply in the first instance are timber and the necessary bolts, and when the shelter has been fixed and inspected, old bricks or other material for blast walls will be supplied. The timber has to be cut to the required lengths, and the bricks in many cases have to be cleaned. Persons with reasonable ability to carry out rough household carpentry and odd jobs are able to do the work for themselves.

The schedule of materials required is as follows :—

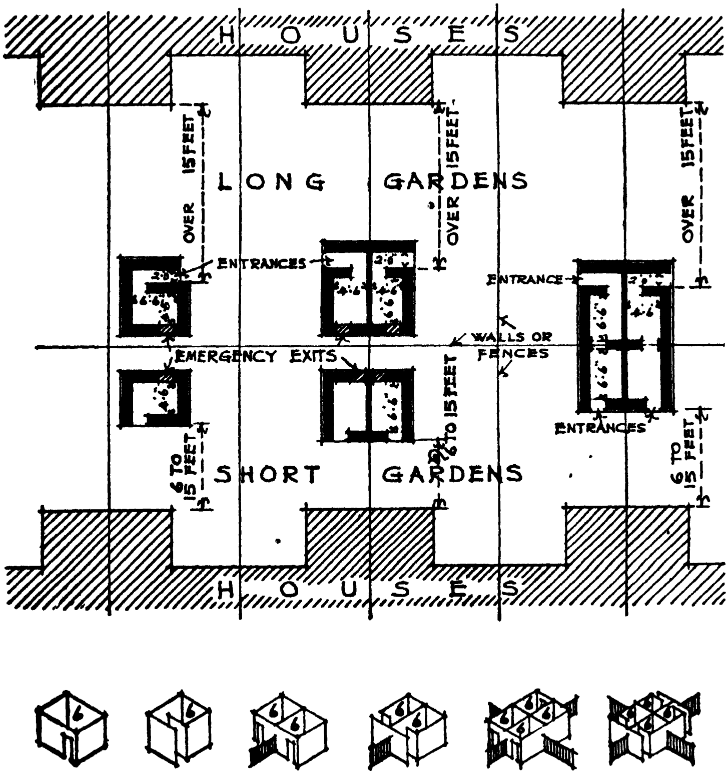
Timber—4 in. by 2 in. 5 lengths 6 ft. 6 in. long ; 2 lengths 6 ft. 3 in. long ; 2 lengths 4 ft. 6 in. long ; 2 lengths 3 ft. long ; 2 lengths 1 ft. long ; 2 lengths 9 in. long ; 2 lengths 4 in. long.

Timber—4 in. by 3 in. 2 lengths 4 ft. 3 in. long ; 2 lengths 2 ft. long ; 2 lengths 9 in. long.

Six hardwood wedges.

4½ in. diameter steel tie-rods, cranked and threaded. Four nuts and washers. Six nuts, bolts and washers; a quantity of 6-in. nails. 4 wood screws and washers.

Where the problem appears to be almost insoluble by reason of high subsoil water level, domestic surface shelters are provided free to eligible householders where a site is available which is not suitable for the steel shelter.



DOMESTIC SURFACE SHELTERS

The plans given above show the type drawings prepared by the Home Office[1] indicating the single unit shelter and the various

[1] Directions for the erection of Domestic Surface Shelters.

multiple lay-outs. The cost of the single unit shelter (without floor or traverse) to accommodate 6 persons has been estimated by the Home Office to come up to £19-10-0 erected complete.

It has a reinforced concrete roof, and a concrete floor (if required). The walls could be either of brick, mass concrete or concrete blocks.

Experience, however, showed that people preferred to stay at home in spite of raids during nights, for various reasons. Government evolved an indoor shelter for free distribution among the people instead of the Anderson Steel Shelter.

The Department of Home Security now issue this new indoor shelter resembling a big table. It can be easily converted into a splinter-proof shelter at night and used as table during day as announced by the Ministry of Home Security in Parliament.

The new shelter as announced by Mr. Herbert Morrison is for installation on the lowest floor of two or three-storey houses and will hold two adults and one older child or two younger children. Experience emphasise the advantages of the indoor shelter achieving the object of dispersal, of warmth and dryness and avoiding leaving the house at nights and the dislocation of family life. Experience has also shown that houses afforded more protection than was once thought. Experts have produced a strong steel structure for use inside the house. It can be used as a table for meals or work so that the whole room is not put out of action. At night screens are hooked on to the sides. There is the added protection of the house walls, a steel top to support debris and a way of escape through detachable ends and sides. The table-shelter has been so designed that householders can put it together themselves with spanner and hammer—important because there is no labour to spare for erection.

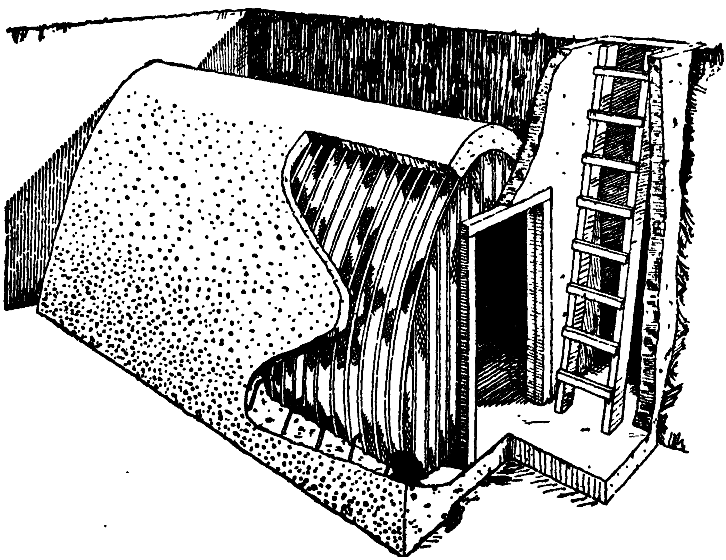
Various kinds of domestic shelters have been suggested. They consist of steel shells like the Anderson Shelter to be embedded and covered with earth or concrete or erected on the site like the domestic surface shelters in brick or concrete.

The Wilmot's "Fortress" is let in the ground to a minimum depth of 2 ft. 6 in. and may be covered over with concrete, earth or sandbags. The inside can be made comparatively comfortable by forming the floor and seats with boards. It is made of galvanised

corrugated sheets, built in the form of a rigid arch, mounted on angle-iron frame. The ends are formed of stout timber, covered with flat galvanized steel. One end is provided with aperture and doors can be fitted if desired, also 21-in. square hinged shutter at the rear end for use as escape shaft. The two standard sizes will seat six or twelve adults. The actual height of the shelter is 4 ft. As the base is fixed on the seating level, the necessary extra height is obtained by excavating for leg room. Prices in Great Britain are :

Six seater 5 ft. long 4 ft. wide	£4-10-0
Twelve seater 10 ft. long 4 ft. wide	£6-10-0

Similar to these are Booth's garden shelters. They could be covered with sandbags or sunk in ground and covered with earth or concrete. They could also be erected partly sunk. Concrete shelters reinforced with steel as shown in the figure are recommended



Concrete shelter with steel reinforcement, for six persons

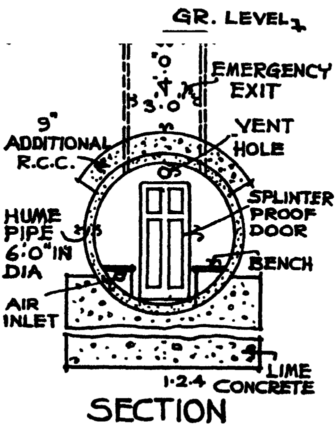
by another manufacturer. The " C " type shelter (concrete cut away) to show curved " Self-centering " steel framework) accommodates 6 persons. Top of arch is 3 feet below ground level and the access is through a ladder. The framework is curved ready for fixing, and can be quickly and easily placed in position.

Under certain conditions they may be placed below the ground floors of buildings. Both partial framework and reinforcement are offered by this kind of prefabricated steel shell.

There is another type semi-circular in shape for over ground erection, away from buildings to accommodate 6 persons. Different varieties of domestic concrete shelters have been suggested by associations established for furthering the cause of cement. The circular pit shelter is erected in the garden at least 20 feet away from a building. The cost of materials comes to about £7 and it is considered that it can be erected by any amateur who has experience of concrete work, in the garden.

Concrete blocks could be used for the erection of surface type of shelters and may be covered with sandbags and earth ; sandbag on the roof above the entrance and a layer of earth 1 ft. 9 in. deep over the remainder of the roof, and earth piled all round the wall. A gas curtain could be fixed to complete the shelter.

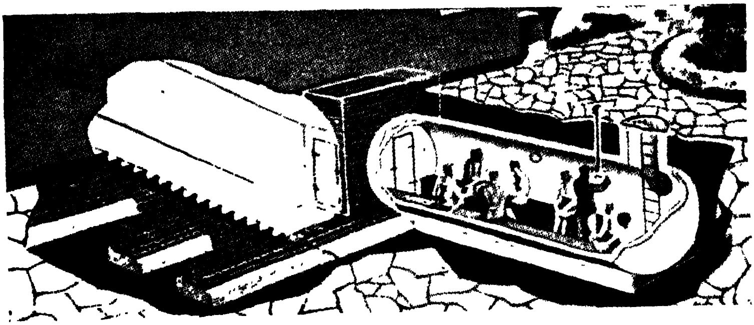
Large diameter concrete pipes make excellent splinter-proof shelters, if buried, or if covered with a layer of concrete or a mound of earth. The pipes are laid like a section of a sewer. Suitable pipes or tubes may be obtained from concrete pipe manufacturers and installed by any builder or contractor who has the necessary lifting equipment. In Spain large diameter concrete tubes were driven into hill sides to provide protective accommodation.



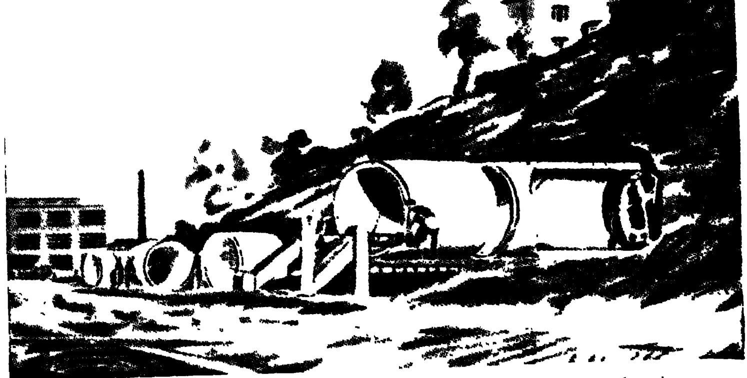
Tube shelter in position showing one end

If possible the tube should be installed either well clear of buildings, or at right angles to the house, so that the emergency exit is always free and available.

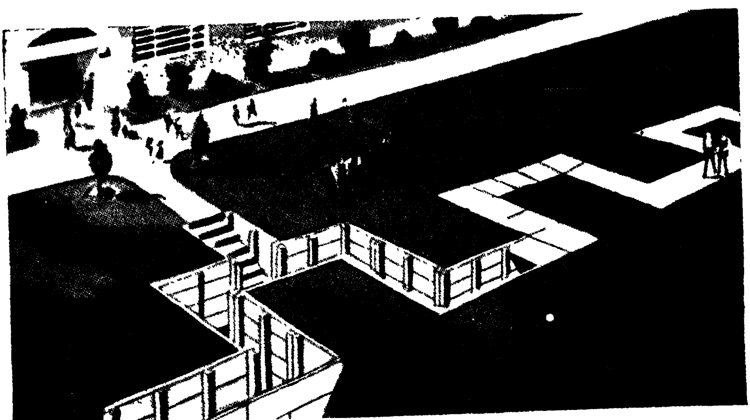
If the shelter is ventilated by having the entrance left open, it may be occupied for an unlimited period, gas masks being



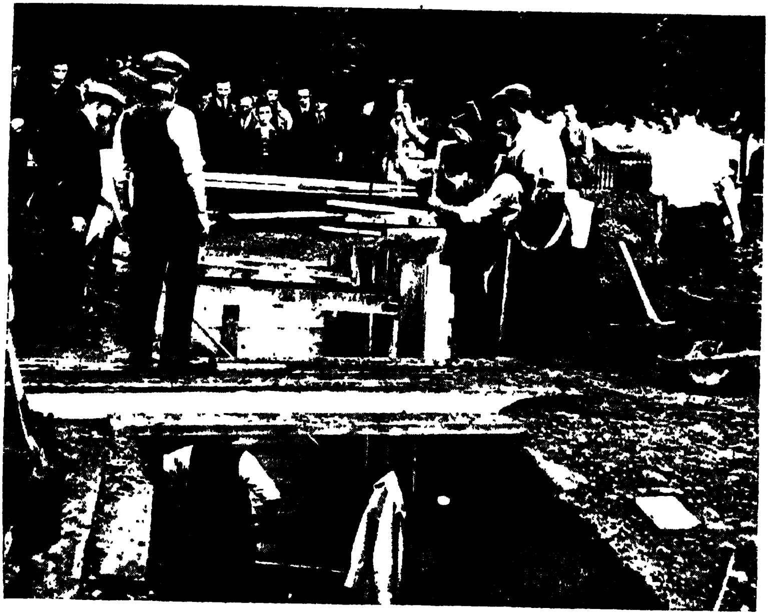
A concrete pipe Domestic Shelter



Large precast concrete tubes inserted into hill sides or slag heaps make Air Raid Shelters



Trenches lined and covered with precast concrete slabs



Covered trenches in the course of construction in London

An air raid shelter for 25 persons on a 120-ton barge on the Thames

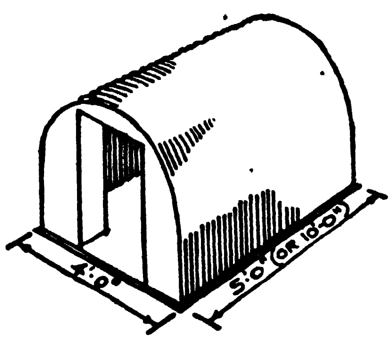
carried by the occupants for use in the event of a gas attack. If the shelter is provided with a gas-tight door or screen it can be occupied for only a limited time, unless the door is opened periodically to admit fresh air ; alternatively, a ventilation and gas filtration plant, capable of delivering 150 c. ft. of filtered fresh air per person per hour, may be installed.

Such concrete tubes could be manufactured locally as also concrete blank ends, door frame sections, and other parts necessary for complete tube shelters.

Tube shelters may be placed entirely below ground level or partly above ground ; in the latter case the protruding portion of the tube should either be encased with concrete 10 in. thick, or covered with a mound of earth (30 in.). In either case the tubes should be placed on an even bed of mass concrete laid at the bottom of the excavation.

Suitable diameters, range from 4 ft. to 7 ft. 6 in. In the smaller sizes a single bench seat may be provided, allowing a 2 ft. length for each person. In diameters of 6 ft. and over two benches may be installed so that the occupants sit in two rows facing each other ; in this case one person can be accommodated for each foot length of tube. This assumes that either a ventilating plant is installed, or fresh air is admitted.

With corrugated iron shell as a frame and reinforcement, small family shelters could be erected with concrete. Curved, corrugated iron sheets may be purchased. Alternatively corrugated iron air raid shelter " Shells " complete with framework, bolts, door, etc., may be purchased from various firms. A small " Shell " as shown is obtainable from many builder's merchants and is made in sizes 4 ft. wide and 5 ft. long to seat 6 persons, or 10 ft. long to seat 12 persons.



A typical steel shell for erecting family shelters

The entrance steps and sides are also concreted and opposite the entrance a masking wall is erected to give protection from splinters.

The pill-box dual purpose A.R.P. shelter discussed in detail later is erected above ground and is blast and splinter-proof. Either stone, brick or cement concrete could be used and it is perhaps the most desirable overground shelter for the family.

In principle there are two types of concrete shelters. Both involve a covering of earth to protect the occupants from splinters unless the concrete itself is of splinter-proof thickness; 15 in. of unreinforced concrete or 12 in. of reinforced concrete. One type comprises precast units, which may be purchased from precast concrete firms, and erected at the site: the other type which is especially recommended for wet situations, is constructed of reinforced concrete, which involves mixing the concrete at the site, and placing it in a plastic condition between temporary wooden shuttering, erected in advance to give the shelter the shape required.

Although the above-ground or surface splinter-proof shelter possesses undoubted advantages, such as immunity from flooding risks and greater suitability for use as a garden shed or cycle stores etc., the below ground or partly buried shelter is in some cases, considered preferable and in normal times may serve as store for fruits, vegetables, etc. For example, considerations of available space, the slope of the ground, interference with the garden lay-out, or the fact that the standing water level in the ground is permanently below that of the floor of the proposed shelter, thus facilitating excavation, may influence the choice of type and favour below-ground construction.

In all sunk or half sunk shelters care must be taken that the floor is strengthened to resist upward water pressure if the ground water level is more than about 1 foot above the underside of the floor slab.

Another variety is the Garden Trench.[1] Where space is available in a garden a trench provides protection except against direct hits. In order that the trench shall be clear of any chance of being buried under wreckage it has to be at least of 20 feet from a building. A trench for 6 persons is shown in the opposite page.

[1] Home Office Pamphlet on Garden Trenches.

The bottom of the trench is 6 ft. below ground level and the width is 3 ft. 6 in. at the bottom of the trench and 4 ft. 6 in. at the top. It is divided into three sections:

1. A Shelter, 10 ft. long, in which the occupants sit on a seat along one side.
2. A covered entrance, 3 ft. long, with a sloping gas curtain resting against a wooden frame.
3. An entrance, 3 ft. long, giving access to the shelter from the outside by means of a ladder. Over the entrance is a wooden cover or trap.

The bottom of this entrance should be lower than the floor of the trench to collect any water leaking into the trench.

Fig. 1

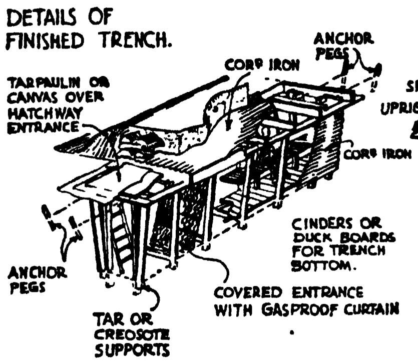
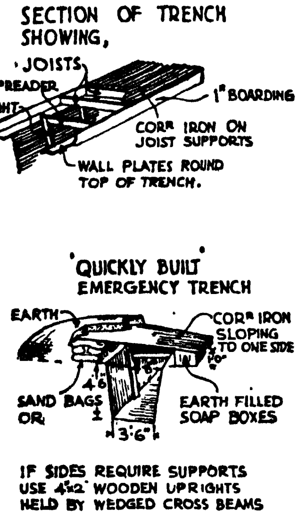
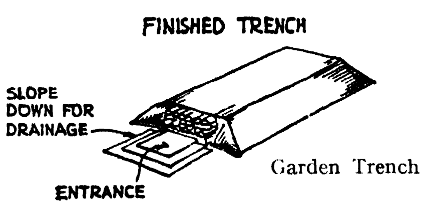


Fig. 2





Garden Trench

Fig. 3

The trench is lined to prevent the sides falling in. The drawings show how this can be done using corrugated iron sheets held in place by wooden frames. The frames consist of 4″ × 2″ uprights on each side of the trench, placed at 3 ft. intervals, with 4″ × 2″ spreaders fixed between them at the top and bottom to hold them apart

(*see* Fig. 2); instead of corrugated iron, wooden planking or sheets of any available and suitable material can be used for the lining.

The top of the trench, except the entrance, is covered with the earth which is obtained from the excavation. The earth is carried on a roof consisting of corrugated iron sheets laid on 5″ × 2″ wooden joists 2 ft. apart resting on 6″ × 2″ wall plates. Instead of corrugated iron, planking or other suitable material can be used. If joints smaller than 5″ × 2″ are available they can be used, but would have to be closer than 2 ft.

The gas curtain can be made of blanket. Light wood slats are fastened to the blanket about 2 ft. apart to keep it hanging flat and closely against the inclined frame. Twelve inches of blanket should be left trailing on the ground to prevent air passing underneath it. In actual use the blanket should be kept wet. When not in use the blanket should be rolled up the inclined frame and held at the top by cords.

The fitting of the lining of the sides will require at least two workers. When it has been completed, the wall plates, joists and corrugated iron for the roof should be fixed in position and finally the earth placed on the corrugated iron sheets, as shown in the figure. The earth face over the entrance should rest against a wall of earth in sandbags, sacks or boxes as shown.

At the two ends of the trench, the tops of the four uprights should be anchored back by means of wire lashings to the anchor posts driven into the ground.

If the number of persons to be accommodated exceeds 6, an extra length of 1 ft. 6 in. per person should be added to the 10 feet length of the shelter; similarly if the number is less than 6, the length of the shelter can be reduced by 1′ 6″ for every person less than 6.

The length of the shelter shown in this design is the minimum required to accommodate 6 persons when sitting close together. With the gas curtain and trap closed, the air in the trench may become oppressive after some time and it may be necessary to open the entrance and admit air, after the occupants have put on their respirators. If the trench is extended to provide a length of 2 ft. 6 in. per person in the shelter, the six occupants should be able

to remain therein, with the gas curtain and trap closed, for a period of 3 hours.

It is important to provide drains to prevent surface water from running into the trench.

If, when digging the trench, water is found before the depth of 6 ft. is reached, work should be stopped above the water level and the extra height required should be obtained by banking up earth above ground level.

In some loose soils it may be found that the sides begin to fall in before the full depth is reached, and in this case it will be necessary to use some of the riveting material as temporary supports to the sides whilst the full depth is being dug.

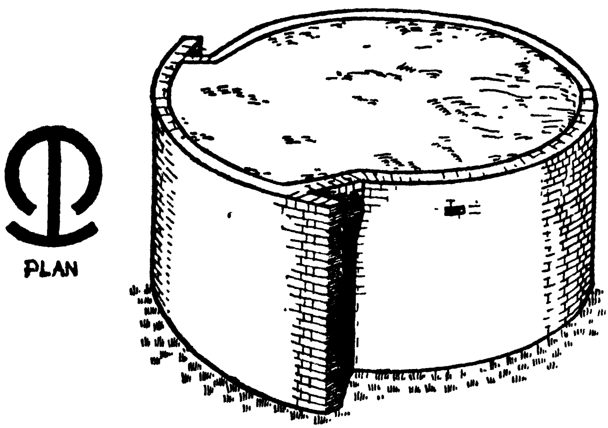
The design of the shelter is so simple that the Home Office of Great Britain considers that it should be possible for most persons to construct it themselves and it may be practicable to use other materials which the householder may happen to possess.

If new materials have to be bought, the average cost of the materials alone (excluding labour) is estimated to come up to about £8 in Britain. If circumstances do not allow of the trench being completed as shown in Fig. 1, it can be brought into use as a means of refuge from blast, splinters and weather, if dug to a depth of say 4 ft. 6 in. Walls could be built on the ground at the sides of the trench about fifteen inches high and corrugated iron sheets laid on the walls as shown in Fig. 4. A few inches of earth could be spread over the corrugated iron to keep the sheets in place.

The shelter thus made is, of course, not gas-proof and if, after a period, the sides show signs of falling in, some sort of lining will have to be provided.

Brick shelters are also largely advertised and several have been built in the streets of London. Among those recommended for families are many types. The Pill-box pattern brick surface shelter could be erected at a cost of under £2 per head by eliminating concrete for the roof and utilising a construction of railway sleepers, light rails and earth cover. Shelters are designed to accommodate either 12 or 24 persons with a space allowance of 3¾ sq. ft. per person in accordance with official requirements. An alternative roof construction is 6 in. of unreinforced concrete with 18 in. of earth cover.

All these are independent types of shelters. But protected accommodation is also possible within buildings, *i.e.* in basements if they are fit for strengthening. If basements of houses are suitably strengthened to provide the required lateral and overhead protection and equipped with emergency exits, they would serve as air raid shelters, proof to blast and splinters. In fact, many European countries rely upon the strengthened basement a great deal, and it holds the second place in the shelter policy of Great Britain, the first being sectional steel shelter. For commercial and business premises this is even more strongly advised.

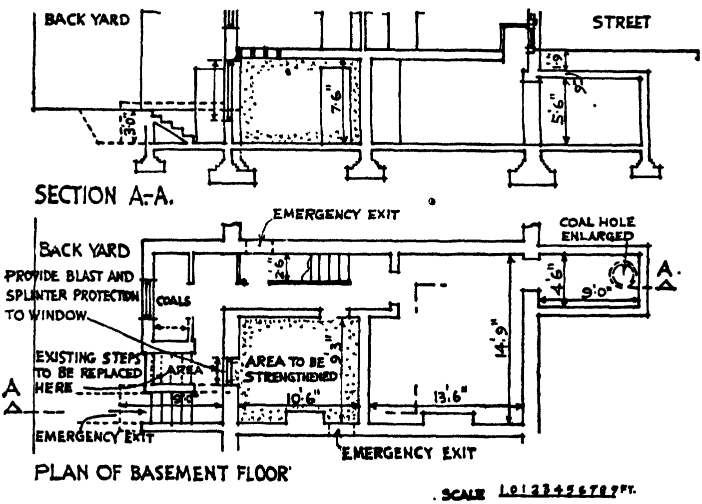


Brick Surface Shelter

Basement shelters resemble cellars provided with easy access. Being below ground level they offer good protection from blast and splinters but care should be taken that the ceiling is sufficiently reinforced to bear the load of the building, should it collapse and the access is not covered up by debris. A single chamber is sufficient and gas locks could easily be equipped. A small toilet room and a chemical closet as well as emergency exit are also recommended. Existing basements could by suitable strutting, be strengthened to form a safe shelter. But even otherwise a dual purpose basement could easily be constructed in houses built without them. Twelve inches of reinforced concrete is suggested for the walls and it is desirable that the roof and floors are equally thick. By suitable design daylight could be admitted into such shelters. We need not

enter into the detailed specifications of roof, walls, floors, water-tightness, etc., but we should emphasise the need for a gas filtration plant if it is to be large and the shelter to be gas-proof.

The advantages claimed for such shelters are: they are not exposed to blast and splinters; they will not require extra space; they will be easily accessible; twinning and double twinning of individual shelters beneath one roof and with common party walls will enable marked economies to be realised whilst preserving the exclusive use of each shelter to its owner; they will have a peace-time use.



A Strengthened Basement for a family of seven persons

But we should remember that these are possible only where basements are common, unlike Indian homes. And where available they could be safe only when properly located and the overhead protection given and the lateral strength obtained are adequate, when they do not interfere with the underground drainage and mains, and when they are properly ventilated and safe to get in and get out.

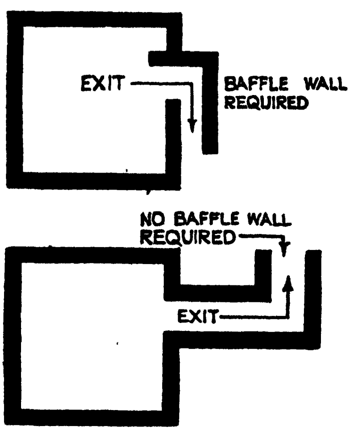
Where neither basement nor independent shelters are possible, a ground-floor shelter planned for a dual purpose would be suitable. A small room such as the scullery or larder can be constructed. The walls should be splinter and blast-proof in concrete or brick and

concrete or lime mortar; the doors and windows should be gas-proof. Timber about 2 in. thickness, may also be used for the door.

To many houses in India it would be useful to build in the ground-floor a strong room convertible into blast and splinter-proof shelter when required. This is especially suited to the residences of the well-to-do who live in houses without space around, situated in congested areas. They obtain fire-proof strong room which is ever useful. In rural areas this type will be particularly valuable.

For urban houses where space is available a lean-to-shelter can be made. Only subsidiary bearer wall will be needed to support the roof. The roof may also be flat and covered with a floor bed giving extra protection. During normal times it could be used as a store for combustibles or valuables or as servants' quarters. The entrance may be direct from the house or independent but both are desirable.

An important detail of construction is the entrance, and the adequate protection of this by means of an earth bank, traverse, or baffle wall does not need elaborating. Ramps leading to sunk shelters are unsatisfactory; they are wasteful of material and space, and dangerous if the floor is wet or frozen.



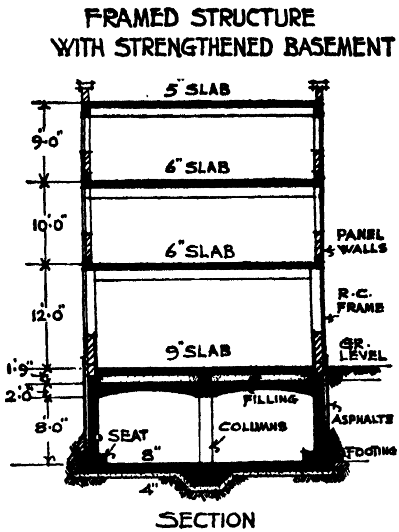
Types of traversed entry

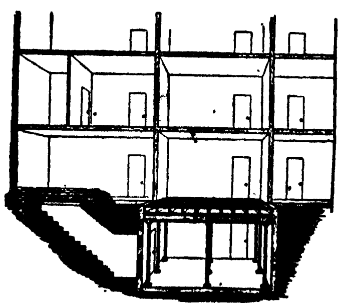
Doors are not always necessary at the entrances to shelters, but they may be considered desirable to prevent unauthorised entry. A position for a door and fixings to render it gas-tight when necessary should always be provided. Shelters for twelve or more persons must have entrances 2 ft. 6 in. wide, and entrance doors should preferably open inwards.

Emergency exits must be sufficiently light to be easily lifted.

Medium Size Shelters

There are many types of shelters which are larger than these and intended for 20 or more persons, for offices, business premises, etc. Pre-fabricated steel unit shelters with concrete or earth cover, concrete trench shelters, semi-sunk dual purpose independent ones, strengthened basements and other varieties are in vogue. All who manage factories or own commercial buildings in vulnerable areas, if there are more than 50 occupants, provide shelters in Great Britain. Strengthened basements are a prominent feature, for space around commercial premises in crowded localities, is not generally obtainable. Special attention has therefore been devoted to this question by the Government of Great Britain. Exacting conditions are stipulated to render them safe.





A Strengthened Basement with emergency exit for an office building

Where it is proposed to make a shelter within a building, either in a basement or in the ground-floor, it is necessary to ensure that the floor over the shelter is adequate to support the fall of debris consequent on the demolition of the superstructure ; but where there is not a substantial building or structure above the shelter, it is also necessary to ensure that the floor provides the minimum overhead protection indicated below.[1]

[1] *Vide* " Revised Code for Aid Raid Shelters for persons working in Factories, Mines and Commercial Buildings."

Overhead protection should be provided by means of not less than :—

1. ¼ in. thickness of mild steel plate.
2. 4 in. thickness of structural concrete reinforced if and as necessary or otherwise suitably strengthened or effectively supported.
3. 6 in. thickness of ordinary concrete, reinforced if and as necessary or otherwise suitably strengthened or effectively supported.
4. Concrete in hollow type construction conforming with the requirements of the Home Office.[1]
5. 8½ in. thickness of arching in sound brickwork or sound stonework.
6. 1 ft. 6 in. thickness of ballast, broken stone or earth.
7. A corresponding aggregate thickness of a proportionate combination of such materials, or
8. A substantial building overhead consisting of a roof and not less than two floors (including that covering the shelter) where such structure is enclosed with walls of brick, stone or concrete.

Adequate provision must be made to afford protection from falling loads due to the collapse of any structure over an air raid shelter if within a distance from such air raid shelter equal to one-half the height of such structure, by the provision of a floor or by the strengthening of the existing floor where necessary or by a suitable roof or other construction based on an estimated static load as representing the effect of impact.

To provide protection from falling loads due to the collapse of the structure above, it is prescribed " provided that where such falling loads would include heavy machinery, materials and goods of abnormal weight for such constructions as chimney-shafts, towers,

[1] See Appendix to Part I of the Revised Code, p. 11.

heavy colonnades, pediments or cornices, but would comprise only the loads of a normal structure and superimposed loading of ordinary goods or light plant and equipment, it shall suffice if, for purposes of calculation, the falling loads be deemed to be static loads in accordance with the following requirements."

1. For buildings wherein the loads are carried on load-bearing brickwork or stonework :—

Number of storeys at a higher level than the top of the shelter	Minimum static load (in addition to the floor load) to be assumed to represent the effect of the debris: lb. per square foot of floor area.
1 or 2	200
3 or 4	300
Over 4	400

2. For buildings wherein the whole of the loads are carried on steel or reinforced concrete framing, the effect of the debris load may be assumed to be a static load of 200 lb. per sq. ft. of floor area (in addition to the floor load) irrespective of the number of storeys at a higher level than the top of the shelters.[1]

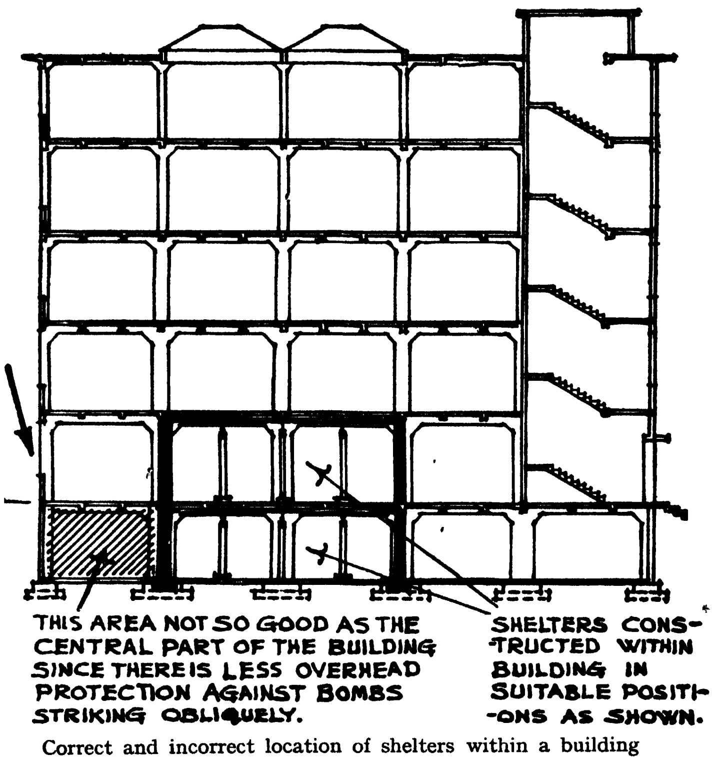
There are three other methods by which the required shelter may be obtained within a building. Trenches or tunnels may be constructed beneath the lowest floor of the building ; existing rooms on the ground or other floor may be adapted to provide shelters. The walls must be made to afford the standard of lateral protection indicated already and the floors or roofs over them where necessary must be strengthened to support the debris of the structure above in the event of collapse. Shelters may be specially built within the buildings, or "lean-tos" may be erected against a wall of the building or against a boundary wall.

The system of constructing trenches beneath the floors provides good protection, and is suitable for adoption in some buildings where there is no unoccupied ground available. It offers the advantage that alterations to the structure of the buildings are reduced to a minimum. The tunnels normally should be kept well clear of stanchion bases, etc. The external openings should be protected in an

[1] For space required, limits to number of persons and separation of shelters, access to shelters, emergency exits, sanitary accommodation and lighting, see Air Raid Shelters for persons working in Factories, Mines and Commercial buildings, Revised Code, August, 1939, Home Office Publication.

emergency by earth or other form of screen wall. In peace time, such tunnels could be used as store rooms or cycle-sheds.

The trench shelters should be distributed throughout the building, and should be placed between the lines of stanchion so that they do not interfere with the footings and foundations. They should, wherever possible, be spaced at least 25 feet apart. In places where depth of excavation is not of importance the shelters may be constructed so as to have a cover of earth not exceeding 2 feet in thickness in addition to the normal thickness of floor. They can be lined permanently with brickwork, concrete, or other suitable material. Access to them should be from the workshop

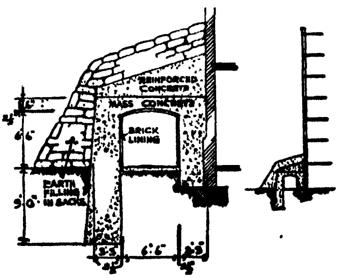


Correct and incorrect location of shelters within a building

floor, and an emergency exit should be provided clear of the building. As this exit is only for emergency use, it need not be of large dimensions, and a pipe 2 ft. 9 in. in diameter, as a " crawl away " and leading to a manhole, would serve the purpose. The emergency exit would also assist in ventilating the trench.

Where there is no basement but where there is a substantially built section of the building as, for instance, a section of an office block adjacent to a single-storey block with roof lighting, it may be possible to select a room or rooms in this section for conversion into shelter. These rooms should be on the ground-floor wherever possible, but in certain cases it may be preferable to provide shelter accommodation on upper storeys, though this should only be done under expert advice. If the ground-floor has large window openings, such as show rooms or shop fronts the shelters should be made in inner rooms or corridors protected by adequate walls. As the enclosing walls of the shelters should be not less than 12 in. of reinforced concrete, some thickening of the existing walls and protection of door and window openings may be necessary, so that the installation can be completed immediately an emergency arises. The floor or roof over the shelter must be strengthened as for basement shelters and all loading occasioned thereby safely transmitted to the ground.

A lean-to against a single-storey building would not require a roof of heavier construction than that required to give the standard overhead protection, but against multi-storey buildings it is obvious that the structure would need to be sufficiently strong to withstand the debris load consequent on collapse of the wall of the main building. Lean-to shelters can serve in peace time as cycle sheds or store. An entrance can be made to give access directly from the main building in an emergency.



A lean-to air raid shelter easily accessible from the street

Entrances and passages giving access to them should be boldly marked and be straight and unobstructed. A safe horizontal space to allow for the passage of a person is 22 in. Taking this dimension as a unit, openings should be designed on the basis that a crowd of persons will pass through an opening at the rate of 40 per minute per 22 in. unit width of opening. The minimum width of 2 ft. 6 in. is required for the convenient passage of a stretcher.

The principle which should be observed is that the entrances and exits of shelters should be so constructed as to diminish the likelihood of all being blocked by debris in the event of the collapse of building structures above the shelter. Where it is not practicable to provide emergency exits clear of the area which might be covered by debris it may in some cases be expedient to provide alternative exits in excess of the minimum required and as widely separated as possible. In basement shelters in closely built-up neighbourhoods it will often be desirable to form emergency exits into adjacent basements.

Among the many types of shelter outside the premises overground shelters in brick, and rectangular in shape, may be considered suitable to our country. Such ones in concrete partly or wholly beneath ground level has been recommended even in Great Britain.

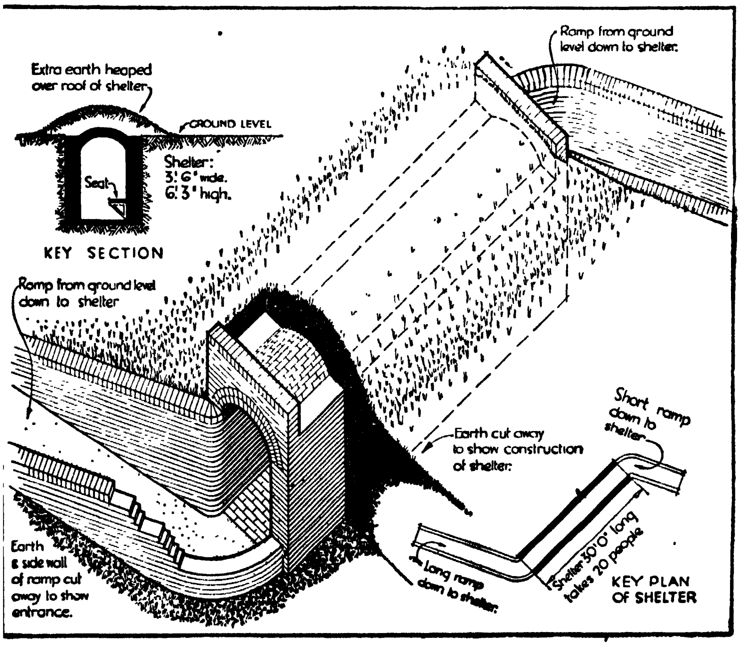
In the interest of safety and efficiency.

1. Parties should be limited to 50 persons.
2. Distance between underground shelters must not be less than 25 ft. Distance between isolated shelters completely above ground must not be less than 50 ft.
3. Entrances should be 2 ft. 6 in. wide.
4. Sanitary accommodation should be provided; one seat for 25 persons with subsidiary facilities.
5. The emergency exit must be such as to provide an opening to the air adequate to natural ventilation.
6. Shelters need not be gas-proof, but it should be possible to make them gas-proof in an emergency.

A convenient type of independent shelter erected with brick and concrete is the trench as shown in the opposite page. It could be constructed for 20 to 50 persons at a cost ranging from £2-0-0 to £2-14-6 per person.

The trench air raid shelter is a simple unit capable of taking 20 people (allowing 1½ ft. run per person). The accommodation of such a system can, of course, be increased by building short traverses to link such a trench up with one or more parallel trenches, additional entrances being provided where necessary. The minimum

width of such a trench system should be 3 ft. 6 in. and may be increased to 6 or 7 ft. where the trench system has to be placed in a limited area of ground and the accommodation required is maximum. The brick arch roof is capable of carrying a considerable load and earth banking should be superimposed thereon as an additional protection. The Code attached to the Civil Defence Bill lays down that Trench Shelters shall provide 3¾ sq. ft. of floor area for every person. The trench shown above gives 5¼ sq. ft. per person.

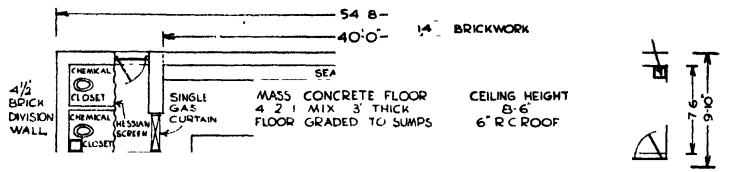


Brick trench for twenty people

The actual cost of one example of a brick lined and roofed trench system was £54-10-0 per 30 ft. of trench holding 20 people *i.e.*, £2-14-6 per person or 36/2 per foot.

Precast concrete units as well as pre-fabricated steel shells are also used for medium size shelters. Sectional construction enables accommodation to be provided quickly to suit requirements.

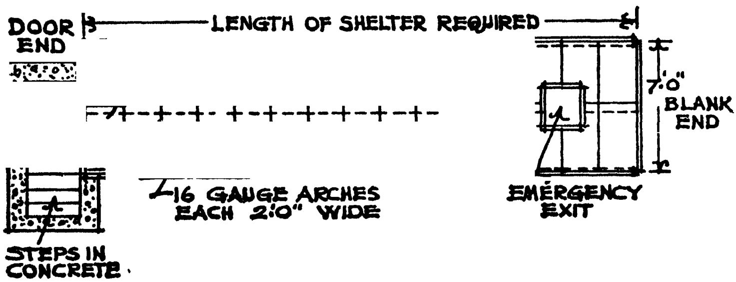
Shelters erected with precast concrete slabs are clean, easy to instal and need no upkeep expense. Expanded metal is also used, cut into units of standard dimensions.' These independent shelters are more or less similar in design and are equipped with an emergency exit. An air lock is also provided.



Plan of an overground shelter for fifty persons

Steel units all bent, bundled and referenced ready for immediate assembly by the contractor in accordance with detailed drawings, are manufactured by engineering firms and shelters can be easily erected. Ranging from 2,. pounds per head, if it is overground and £2-5-0 if partly sunk, these provide safety, from blast and splinters. An air lock in the entrance would protect against gas.

MEDIUM SIZE SHELTER FOR 50 PERSONS

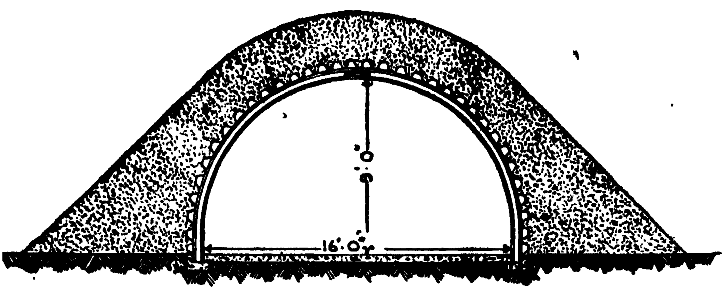


Dovetail steel sheets 16 gauge, bowed to form an arch, and connected by an interlocking joint at the centre, dipped after corrugating in black bitumastic paint could be used for shelter construction. They should be covered with concrete, and sunk full or half into the ground. Ends, footings and doors framed in 10 or 14 gauge cold rolled sections, assembled by arc and spot welding are obtainable. A standard type recommended by a leading manuacturer of Great Britain is shown above.

The steps are in concrete. There is an emergency exit. It is 7 ft. wide and 6 ft. 6 in. high. An alternative arrangement of the 7 ft. wide shelter is with the door at the end, instead of at the side. The entrance is then protected by a concrete retaining wall. The steps down to the entrance are at right angles to the length of the shelter. The price of a shelter, 30 ft. long needed to accommodate 50 persons, as given in England is as follows:

30 ft. run of 16 G. arches	£39	0	0
1 Door End	£ 7	16	10
1 Blank End	£ 5	16	9
1 Emergency Exit	£ 1	18	11
Nett ex-works ..	£54	12	6

Another variety consists of ready-made arches, struts and arcuate sheets. The arches are spaced 3 feet apart. The width inside the sheeting is 7 ft. 6 in. and seating can, therefore, be arranged as in an omnibus (a normal omnibus is 6 ft. 9 in. wide inside) with two persons on either side of a central gangway. In this way people can enter their seats without disturbing those already there. An average of six persons can be seated per yard.



Section showing dovetail steel sheets fixed in position in an overground air raid shelter

This shelter can be installed on the surface partially above ground, or completely submerged. A blast and splinter-proof shelter to accommodate 50 persons with emergency exit is priced £50–13–4 in Great Britain.

Large Shelters

Shelters for larger numbers especially for the floating population and for employees in large establishments call for larger accommodation and two varieties are suggested. The simplest is the trench which will provide some protection to those caught in the streets and the other is the large bomb-resisting structure. The former is advocated on the principle that something is better than nothing and the latter is suggested for fear that if they are only blast and splinter-proof a direct hit may entail large number of deaths.

For immediate policy bomb-proof shelters are not advised and trenches are suggested as the solution for protecting the public. Those permanently lined with concrete slabs give a fair measure of protection against blast and splinters. If precast concrete slabs are used to cover the trenches they may be further covered with earth or sandbags for extra protection in emergency. Careful instructions for the design and construction of trenches are therefore given by government, and specifications etc., regarding permanent lining of trenches and trench construction are specially dealt with in their A.R.P. Handbooks and pamphlet by the Home Office of Great Britain.

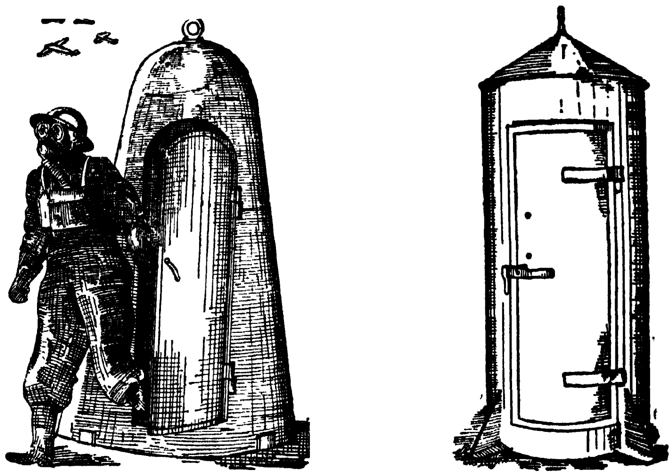
Shelters for Key-men

Protective accommodation required for key-men engaged in A.R.P. services and other duties during an air raid form another class since they need not be as big as even family shelters. But shelters recommended for them must be efficient and strong. There are portable all welded steel shelters affording good measure of protection for one or two or four men. They are equipped with efficient doors, sometimes gas-proof, with natural ventilation and fitted with a seat. Eye slots are provided to give the inmates a clear vision and also permit sufficiently high vision in the sky. Diagram No. 1 on page 287 illustrates the chief features of a type manufactured in Great Britain which is claimed to be proof to shrapnel, falling masonry, blast, etc. It is made in two sizes for two or four men.

Essentially similar but slightly differing in external appearance is No. 2 variety which looks like the pillar post boxes in India.

These have one-piece cone-shaped dome, glazed look-out panel with splinter-proof guard and gas-tight rubber gasket; they are portable and are manufactured quickly in large numbers.

Brick shelters, are also built for air raid wardens affording good measure of protection. Brick warden posts, have been erected in Great Britain and brick and stone ones are advisable for India where welded steel shelters may be comparatively expensive.



2

All welded steel shelters for key-men

The problem of providing protection for people against air attack is a new experience and measures are improvised according to exigencies. Overground shelters affording partial protection were erected in Spain and were soon discarded since they proved vulnerable. Deep underground tunnels were converted into shelter accommodation when raids became more deadly. The shelter policy of Great Britain too has come in for sharp criticism and experts point out several defects. But the policies are based upon local conditions, requirements, materials and exigency.

It has become apparent in England that the shelter problem is not solved if the accommodation erected is only able to withstand bombs and blast. Comfort and convenience within, are now shown to be as vital as strength.

In recent months there has been much discussion about air raid shelters alike in Parliament and in the Press and by the public, mainly as to the sanitary conditions and as to whether the construction originally specified by the Government is an adequate defence against bombs and weather.

Civil Defence Act, 1939 came into force and many attempts were made on a large scale to afford air raid protection by means of shelters. This Act dealt with the provision of air raid shelters of all kinds—public and private—in and over premises, underground or on the surface, those for commercial and residential buildings, factories and workshops.

Shelter Sanitation and Comfort

Deep air raid shelters were banned when the Lord Privy Seal in 1939 refused his consent to their construction,[1] but immediately the "blitz" began in earnest it was found that the types of shelter already supplied or erected gave totally inadequate provision for shelterers who needed to spend the whole or part of the night in them, and, where their homes had been wrecked, part of the day also. In fact, they were not constructed for any purpose but crowded sitting. Consequently the public turned to the more adequate shelter of the underground stations of the Tube system, leaving the official shelters vacant, and the platforms and staircases of the underground soon became overcrowded by shelterers. The authorities feared epidemics and other dangers and were faced with the urgent necessity of providing sleeping accommodation in the municipal shelters, and of rendering them healthy and sanitary.

The position became so acute that in November, 1940, there were presented to Parliament by the Minister of Health and the Minister of Home Security the recommendations of Lord Horder's Committee, which had been given the task of exploring and reporting on the whole problem, and a brief statement of the action already taken by the Government thereon.

One of the principal recommendations of the Committee was "to effect the utmost degree of dispersal so as to deal with the crux of the problem, which is *overcrowding*." Only recently it was announced that dispersal had at least been effected and that health conditions in shelters were now astonishingly good. The provision of "bunking", communal feeding, canteens and the organising

[1] *See* A. G. *v.* Finsbury, B.C. (1939) 3, All E.R. 995.

of recreation and entertainment so essential in the communal life of large numbers of persons have been the basis of this improvement.

It is magnificent that it is impossible to read into the Government definition that an air raid shelter must give absolute protection in an air raid. The authorities have always been careful to state when issuing typical designs that these structures could not be expected to withstand a direct hit, and sad experience has illustrated this.

For example, Anderson shelters when properly covered with earth to Government instructions and provided with splinter-proof screens at the entrance, have lived up to expectations.

The effectiveness of a shelter therefore depends (1) on its degree of protection against bomb-blast and splinters, and (2) on its resistance to damp, its sanitary condition, adequate ventilation and sleeping space for the number of shelterers likely to be admitted.

The Government has gone so far as to admit that ungauged lime mortar was made permissible by their issue of a " certain circular " but indicate that contractors " have gone far beyond anything that was contemplated by the circular," when allowing some departure from the original contract specification.[1]

The Premier assured in January 1941 that the organisation and improvement of shelter condition would be the first task of the Government. Much has since been done to improve condition of shelters.

During October, November and December 1940 accommodation was found for 1,05,000 people. Sleeping bunks for 2,06,000 people had been installed and bunks for over 2,00,000 people more had been delivered to local authorities. The threat to health in large shelters was met and the tube sanitation problem was tackled.

Bunks supplied to dormitory shelters in the London region by Government brought extra comfort to over 1,50,000 people spending the night underground. Delivery rapidly increased ; over 80,000 timber bunks, giving sleeping room for over 2,40,000 people, having now been delivered to the local authorities. Delivery also began for bunks specially designed for the communal surface shelters.

[1] *Vide* " Builder ", May 9, 1941, p. 447.

A ticket system has now begun at 14 tube stations used as shelters and the issue of tickets to everyone sheltering regularly in the tube stations has been started.

Cultural and recreative amenities are also arranged in shelters, as also musical and other entertainments. A library of 5,000 books has been brought for the use of shelterers.

By July 1941 great strides were made in shelter equipment. There were sleeping accommodation in shelters in the London region for 12,77,000 and for 34,95,000 in domestic shelters.

In tubes, where there were 23,000 bunks, a gradual decline in the number of persons using them as shelters had been noticed, and the last census showed that there were 26,000 people using them—the lowest since the heavy raiding began.

With a few exceptions, the local authorities have now completed their plans for providing canteens in shelters holding 200 persons or more, and for the installation of power plants in all shelters regularly used by 50 or more persons.

There were 188 medical aid posts in large shelters and 69 posts serving groups of smaller shelters.

Twenty-four welfare councils or committees had been set up, and more were being formed. Sanction had been given for the appointment of a number of shelter welfare officers.[1]

Five hundred " snore-balls," an American invention to stop snoring were distributed in air raid shelters.

In spite of all these it has been found that the percentage of people using shelters is not very great.

A census taken in December showed that 5 per cent. of the population of the London region occupied public shelters, 19 per cent. domestic and communal shelters and the rest were living in their own homes, according to Sir Wilson Jameson, Chief Medical Officer of the Ministry of Health. In the Metropolitan area, people using public shelters were 8 per cent. and domestic and communal shelters 21 per cent.[2] It is therefore clear that comfort of the occupants is as vital a consideration as the strength of air raid shelters.

[1] "Hindu ", 31-7-1941. [2] "Hindu ", 9-1-1941.

Designs for India

The raid on Rangoon on 23-12-41 has made it abundantly clear that people must take cover in houses or in trenches or in shelters to minimise death and injury to civil population. Otherwise, fragments and splinters take a heavy role.

Slit trenches had already been dug in open spaces in Calcutta so that the members of the public who could not seek shelter in buildings against the effect of bombing in a possible air attack on Calcutta, would be able to find protection there. The policy of the Government for the protection of the general public is well under consideration.

A.R.P. authorities in Quetta have decided to dig a large number of slit trenches in various parts of the city, the total running length of these being about 25,000 feet and will cost the authorities a sum of about Rs. 7,000. The authorities hope to provide adequate covers for these trenches later on, in view of the extreme cold weather experienced there during winter months.

Suitable accommodation has been selected in various Government and public offices in the city of Madras wherein the inmates could take shelter during " Alerts ".

The Government of Madras have provided slit trenches in various parts of the city of Madras for giving shelter to people caught in the open during air raids. The aim is to provide in them accommodation for as large a part of the population as possible up to 25 per cent. in all open spaces in the city belonging to the Government and the Corporation, especially near railway stations. To avoid an undue rush on the available shelter accommodation, the public are advised to remain in their houses during a raid and not to leave them till the raid is over. If, however, they are caught in the open during a raid, they should make for the nearest shelter, irrespective of whether it is a building or a slit trench. They are also advised to construct shelter accommodation in their own houses or dig slit trenches. Occupants of Government bungalows and of bungalows rented by Government should have trenches dug at their own expense.

In India shelter provision is needed for key-men, the floating population, the very poor and the slums, the employees in fairly large establishments, for middle class families, and for the well-to-do.

For key-men, all welded steel shelters might suggest themselves, but in this country warden's post could be erected with brick, stone and concrete at less expense and they would have peace-time use as well.

For the floating population, the slums and very poor, State provision of protective accommodation is inevitable. The cheapest and the quickest type is the covered trench. When recommending this type for such large numbers who constitute the majority of Indian urban population we should keep in mind that it is a very defective measure however necessary. In fact the covered trench was given up in Spain.[1] The reasons given are :—

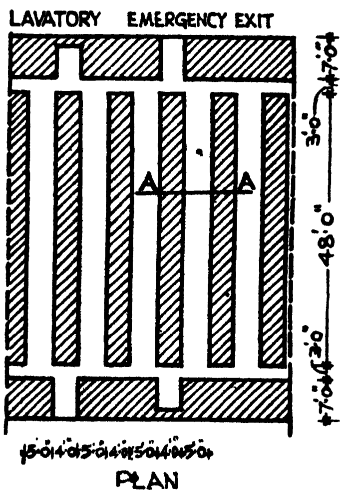
1. The protection given in proportion to the work entailed was much less than with the other types.
2. The difficulties of finding suitable sites in which to place them, especially owing to the fact that with this type of shelter the area of the site needed to accommodate them was many times larger than the effective floor surface of the shelter.
3. The volume of earth to be excavated was practically the same as that for the more satisfactory types.
4. The open spaces, parks, gardens, suitable for such a type were usually too far from the places for which there was need to provide shelters for it was considered that the entrance to a shelter should not be further away than 110 yards from the place of those for whom it was meant to be a protection.
5. The provision of this type of shelter, without overhead protection, except against splinters, could not be accepted as the responsibility of the Government in the general programme of protection, for, as it was building at the same time bomb-proof shelters, it was decided that it should not provide shelters with such varying degrees of protection. Excepting the last, other reasons hold good equally well for our country.

[1] R. Perara, A.R.P. in Catalonia, "Builder", December 15, 1939, p. 28.

To these considerations might be added in India, the danger from gas attack. In a poor country where people cannot afford the mask, trenches will turn into death traps when gas is used, unless they are gas-proof; but this will render them very uncomfortable owing to tropical heat. Further the cost of better class trenches lined and covered with concrete slabs is itself a deterrent factor. Can civic authorities who cannot provide adequate water-supply and public conveniences to the poor and the slums, provide all of them with shelter accommodation however cheap it may be? If a beginning has to be made, it should, in the interest of economy, be such that while offering partial protection at once for emergency it should not prove waste later on.

The problem of "how a programme of partial protection can be rapidly prosecuted in such a manner as to lay the basis for a programme of heavily protected shelters, thus avoiding the enormous waste in time, material and labour which would result if the two programmes were not linked together," has been solved by a reputed A.R.P. body[1] whose designs seem particularly useful to India.

An important feature of the design is that the shelter can be constructed in two stages. In the first stage it gives greater safety than the standard covered and lined trench, but it is capable of being subsequently more heavily protected to give any degree of protection desired, solving the crux of the shelter problem, namely, provision for immediate as well as for long time use.

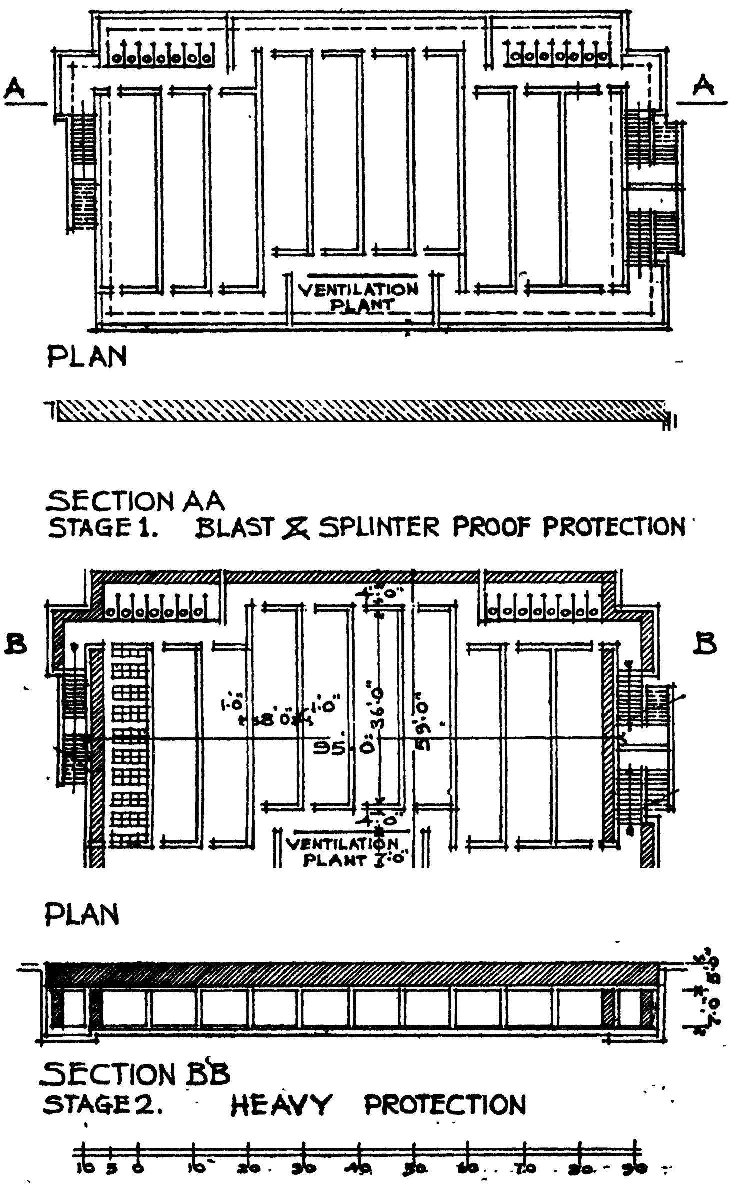


The 'Haldane' Shelter

In reinforced concrete this type of shelter can be constructed either above or below ground and is consequently suitable for both dry and water-logged soils. The shelter is

[1] A.R.P. Co-ordinating Committee's Scheme.

A COMMUNAL AIR-RAID SHELTER



made up of compartments each containing 50 to 80 persons according to the nature of ventilation provided, to localise the effects of bombs. The number of compartments could be varied and the shelter capacity adjusted to local requirements. Seating, lighting, and sanitary conveniences are provided.

In this design attention has been mainly directed to the problem of planning rather than to considerations of details. Shelters of very similar designs already constructed cost about £6 per head for the first stage and without forced ventilation. The cost would, however, come down if mechanical ventilation is provided or if the shelter is over the ground.

This design needs careful investigation for " the final solution of the problem of protection for the civil population in large towns and cities lies principally in the provision of heavily protected shelters." At the same time we cannot ignore the provision of partial protection.

The design has been evolved from the trench. In essence it consists of series of parallel units, either above or below ground, separated by walls of reinforced concrete. Two communicating corridors link up the units and also serve to protect the occupants from the effect of shock waves transmitted through the shelter walls.

The diagram given shows the design for a shelter below ground level. The corridors and the stairways serve to isolate the unit from the shock waves transmitted through the surrounding earth. In the second stage the thickness of the walls outside may be insufficient when compared to the roof to resist the effect of bomb exploding immediately alongside.

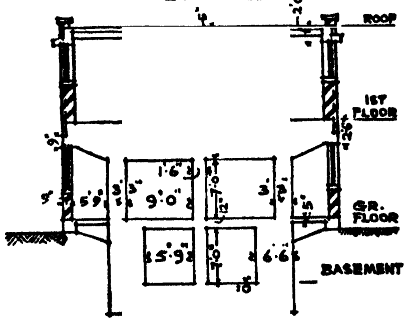
'This could be altered if required but with a given amount of material and up to a certain point better protection is afforded by thickening the roof slab at the expense of the wall thickness . . . . because the probability that a bomb may fall immediately alongside the outer wall is very much less than that it may strike the roof!'

When the shelter is naturally ventilated it will accommodate 576 persons.

By introducing mechanical ventilation, at a rate of 450 cubic feet per person per hour, it is possible materially to increase the

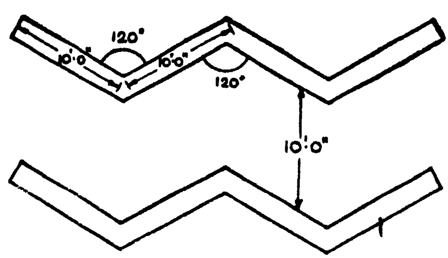
capacity of the shelter, and at the same time to reduce the cost per head. The shelter would then accommodate 770 persons. Seating capacity could be provided for 720 persons, leaving 50 standing occupants.

OFFICE AND BOMBPROOF SHELTER COMBINED.



SECTION

If covered trenches are not possible at least open slit trenches should be dug and provided for the poorer population. Even a depression will help to provide some protection against bomb blast and splinters particularly of smaller anti-personnel bombs likely to be used over Indian cities. The idea to utilise holidays for "digging for civil and self-defence against bombing air raids" is being spread in Burma by the Commissioner of Civil Defence. Many thousands of lives have been saved by remaining in a hole dug into the ground, however shallow it may be. There could, therefore, be no better or indeed more patriotic way of spending a public holiday than by every citizen digging a hole for the purpose either in his own home or wherever the need is greatest. " Civil Defence is Self-Defence." By protecting their own lives, the civil population make a good contribution to victory. Trenches could easily be dug and even the sides could be lined by locally available material at no great expense by local artisans.

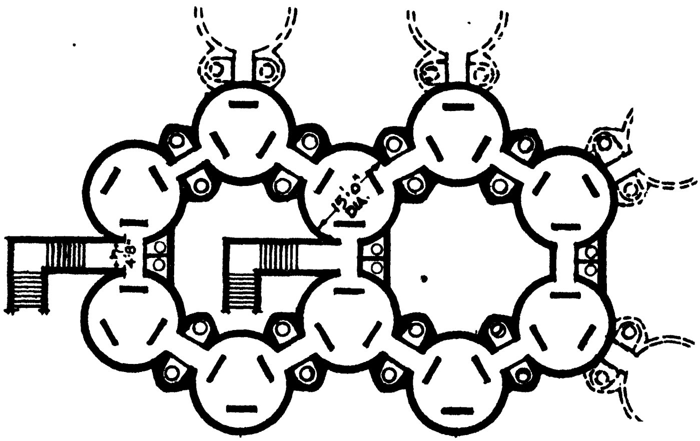


A type of lay-out of trenches for the floating population

The risk of injury to people sheltering in open trenches from machine-gun bullets is not as great as is imagined. When it is realised that air-craft

fly at great height and that slit trenches are constructed in a zigzag fashion, it can be seen that the possibility of accurate shooting at slit trenches by a plane travelling at 200 miles per hour is extremely remote. As a matter of fact, there was very little machine-gunning of persons in shelters in Rangoon.

Safe distance between trenches is, however, not considered necessary by some. "In determining the minimum distance between two trenches, it is assumed that they must be placed so



An economical method of arranging trench shelters for the floating population in open squares

that one bomb will not destroy more than one trench. This is a fallacy," observes O. N. Arup, author of 'Design, Cost and Construction of Air Raid Shelters.'

His reasoning, however cogent, as he himself admits, will not satisfy the average man. "No doubt some people will not be convinced by this argument, because the mental picture of one bomb destroying several trenches and killing, say, a hundred people at a time will outweigh any appeal to mere reason."

His conclusion is "that trenches can be put very close together, probably within 4 ft. to 5 ft., without increasing the danger of the people inside them." He admits that there will be a difference in the average distribution of casualties. Instead of 1,000 people being killed by 100 bombs killing 10 people each, we may get the same number of people killed by, say, 25 bombs killing on an average of 40 each. He, however, admits that where indiscriminate bomb-

ing is not resorted to, the collection of trenches would form a special target and be extremely vulnerable.

In cities, where A. A. defence is very poor, deliberate and daylight bombing would be resorted to and dispersal is absolutely essential. They should further be in short lengths, well-dispersed, zoned to suit actual requirements, adequately provided, easily and quickly accessible and preferably covered.

Arup's conclusion regarding shelters, their design, strength, and distribution are valuable :—

" It is impossible to decide on purely technical grounds what degree of protection against high explosive bombs should be provided for the civilian population, but if it is decided to provide some degree of protection, it is clearly important to spend the money to the best advantage, bearing in mind that it is protection and not merely accommodation that is being purchased."[1]

The problem of the workers and employees is less difficult for, by legislative compulsion, as is done in Great Britain, employers might be compelled to provide shelter for them. According to the Civil Defence Act, 1939 owners of factories or employers of more than 50 persons must provide air raid shelters for their employees in vulnerable areas. A Government grant of 27½ per cent. is made to them. Similar legislation could be helpful to our country.

A.R.P. being a provincial subject, local legislatures should tackle the problem. The Civil Defence Code provides a valuable guide but the designs should be evolved to suit Indian requirements. A convertible garage with possibilities for extension and reinforcement seems the ideal solution both from the point of view of safety and economy.

This will provide for a good section of urban workers. If space is not available around, it could be provided in the basement or ground-floor. The narrow streets of Indian cities would be relieved of congestion if the ground-floors of large commercial buildings are turned into garages convertible into air raid shelters This will not interfere with underground systems like drainage, etc., and would be suitable to most premises, for a ground-floor shelter, would be easier than a basement shelter in buildings.

If the Government in England depends upon the strengthened basement as the companion of the sectional steel shelter to protect

[1] *Vide* ' Design and Construction of Air Raid Shelters '.

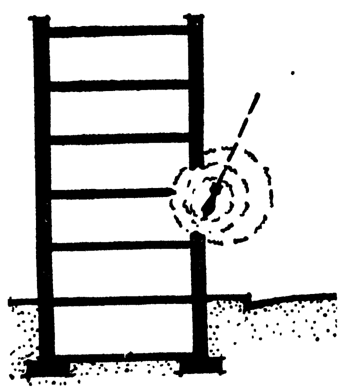
their people, Indian cities will do well to strengthen ground-floors as the solution to this problem. Since most buildings in India are without basements, and since the walls of good buildings are thick enough to afford the standard protection ($13\frac{1}{2}$ in. brick in cement mortar) and as they are load-bearing walls, by shoring and strengthening the ceiling of the ground-floor to withstand the debris load, convertible garages could be speedily improvised.

In fact even in countries where basements are a common feature of buildings, the strengthened basement is becoming less and less popular.

After examination, many basements were found unsuitable in Catalonia. Nothing could be done when the basement needed reinforced protection at the sides or overhead, because, the work and material expended in this way could be utilised to better purpose in the building of proper shelters. Secondly, owing to difficulties of internal wall, conduits, entrances frequently narrow, low ceilings, etc., only a mediocre result could be obtained even after a long period of work. Thirdly, the need to provide uniform degree of protection, could not make this officially accepted, as shelters.

Even when the basements were suitable independent shelters were constructed in buildings as a more advisable proceeding. When the basement had not sufficient head room but otherwise suitable, it was increased by sinking the floor level.

" The strengthening of those basements and the idea of providing support against the debris weight of the collapsed building is considered useless and experience shows that the cause of such collapse is obviously overlooked. If the collapse of the building is a result of a direct hit over the same building, the hits would reach the basement passing through the wall openings and special care is necessary to provide the shelter in a central area in the basement and affording a substantial lateral



The vulnerability of basements to the high explosive bombs

protection by means of additional walls. On all suitable occasions the large cellular type and the tunnel type were built in Catalonia."

These arguments have great force particularly to countries like India where storeyed houses are of poor strength.

The share the Government should bear in their erection, the form legislation should take, are matters of detail but we should remember that they must be such as to be capable of extension and conversion into bomb-proof shelters if required. Their location should be decided with a view to make them the centres of business houses in the city of to-morrow.

For the middle and rich class folk protective accommodation should be provided close to their residence, preferably in the compound and where no space around is available, within the house. The task is best entrusted to owners of residences though advice and guidance might be given free by the State.

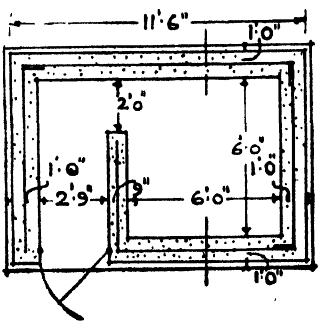
For houses without compounds the strengthened basement, the ground-floor refuge room, a specially built scullery or larder are suggested in European countries. Considering the requirements of the middle class and the well-to-do households and the general type of construction adopted in our country a convertible strong room in the ground-floor suitably placed might be preferred. Erected with brick, stone and concrete and equipped with good quality doors and overhead protection these could replace costly iron safes generally owned. It would be useful throughout the year and would save the transport charges incurred for heavy safes. Particularly in the mofussil such strong rooms are of real value and they could also be used as granaries.

A safety room in a building to be used as a shelter during air raids has been suggested in Bombay. A small room is to be preferred to a large one and should be chosen in a protected part of the building away from the outside panelled walls which are vulnerable to splinters and blast. At the same time, the room should not be too enclosed for there is the risk of falling debris and of being trapped by fire. Further details about the resisting capacity of the ceiling is also mentioned. It is emphasised that every house ought to be provided with a safety room wherever

practicable. The A.R.P. authorities have also specified the equipment necessary for the safety room such as buckets, sand, a set of tools, first-aid outfit, etc.

For houses with compounds, the pill-box shelter is advisable. A unit shelter will suffice for an average family and a double unit for a large one. A twin double unit if constructed at the intersection of 4 compounds would meet the requirements of 4 households at proportionately lower cost.

The unit shelter provides a room 6 ft. square with an entrance lobby.[1] Being protected by 12 in. of reinforced concrete, or 13½ in. of brick in cement mortar, the pill-box shelter is blast and splinter-proof to medium size high explosive bombs exploding not nearer than 50 ft., and does not require a protective earth or sandbag covering.



The Pill-box Shelter

If concrete is used in the construction of the shelter it should not be weaker than 1 : 2½ : 4 mix. The walls should be 12 in. thick reinforced with ⅜ in. diameter bars at 12 in. centres in both directions and the roof slab 9 in. thick reinforced with ⅜ in. diameter bars at 12 in. centres in both directions. If the distance between the shelter and any building which might fall on it is more than half the height of the latter, the thickness of the roof slab may be reduced to 5 in.[2]

Ventilators 4" × 4" splayed horizontally on the inside are formed in the walls and should be fitted with plugs.

[1] "Indian Concrete Journal".

[2] If brick construction is preferred, walls should be 13½ in. brick in cement mortar.

The foundations should rest on well consolidated ground, and should normally consist of a 6 in. thickness of plain concrete, but the part beneath the walls may be thickened and the thickness of the floor reduced, should this seem advisable.

At the junction of the wall with the roof or floor and at any other horizontal joints, a longitudinal groove should be formed in the concrete to provide a key.

Timber plugs 2″ × 1½″ dovetailed for fixing hooks, shelving, etc., should be set flush in walls 12 in. apart 9 in. down from ceiling. Two tapered vent holes should be formed in the walls and in the positions shown on the drawing. The holes should be 4 in. square on inner face, 7 in. square on outer face and each fitted with a concrete plug having contact faces covered with plyboard.

The door should be 1 in. thick, ledged, and hung to a 4″ × 3″ timber frame set flush in the walls and secured by iron holdfasts or bolts.

A blanket or carpet weighed down with wooden slats should be provided of which 1 ft. should be left trailing on the floor, over the side frames.

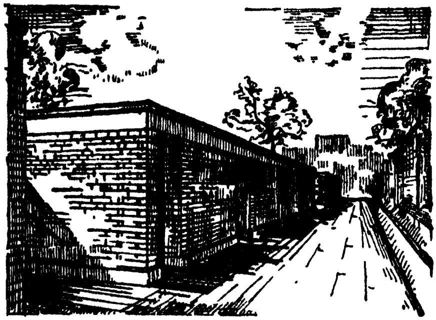
A timber combined bench and locker should be fixed along one side of the shelter, to contain emergency equipment such as first-aid box, candles, matches, disinfectant, water jar, toilet requisites, spare blankets, hammer, shovel, etc.

Brick Shelters

All the types recommended for Indian dwellings could be erected of brick and cement mortar or stone masonry. The domestic surface shelter in the compound whether overground or sunk, the strong room within the house convertible into shelter for houses without compound, the convertible granary for village homes could be conveniently erected with brick and cement mortar provided they are of the proper thickness.

Brick trenches could also be constructed for the floating population. For medium size shelters for commercial and industrial concerns too, bricks could be used. In India where local artisans are used to brick work for ages and where bricks are available all over, there is a strong case for brick shelters. Even in Great Britain interests representing clay products are bringing home to the people the utility of brick for A.R.P.

It is interesting to find that the Home Office of Great Britain in their recent announcement recommends brick and concrete shelters, and brick shelters have been built in the streets of London. Tests have shown that brick work affords a degree of resistance to blast and splinters comparable with anything so far either generally used or proposed.

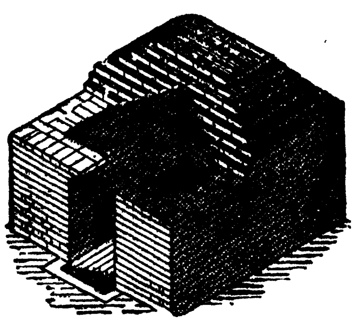


Brick shelters erected in the streets of London

The problem of shelters must be met by utilising and adopting normal building materials, methods, and workmen's experience. The simplest form of single (one family) brick shelter envisaged by the Clay Products Technical Bureau of Great Britain costs less than 20 pounds ; a figure which can be very much reduced in India, especially if the occupants of neighbouring houses co-operate to enable their individual shelters to be semi-detached, with a common party wall replacing two or more separate walls. A further saving will be attained by would-be shelter-owners in a locality combine to place a single contract for all their requirements.

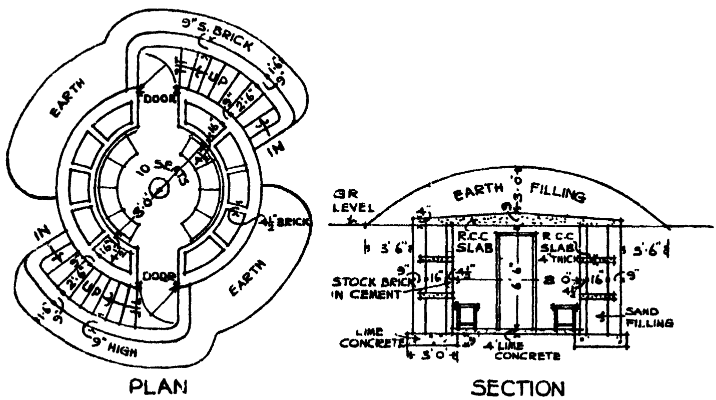
Lateral protection to blast and splinters recommended in Great Britain for shelters proof to a 500 lbs. high explosive bomb exploding not nearer than·50 ft. could be obtained by bricks and cement mortar 13½ in. thick. With brick work construction every builder is familiar and bricks are available everywhere. A higher degree of protection will be obtained if reinforcement into the joints of walls are introduced. For overhead protection from bomb splinters, falling shell fragments and debris consequent on the demolition of neighbouring superstructures, and also against the penetration of the roof by the kilo incendiary bomb concrete roof at least 5 in. thickness of such strength and so reinforced as to be capable of supporting more than the 400 lb. sq. ft. maximum load is recommended. Now that reinforced concrete work could be done in most cities and towns, a 5 in. R. C. Roof is preferable to the Madras and the Bombay terrace. For, to obtain a corresponding strength to resist debris and penetration the latter types of construction would be costlier.

The surface shelter is the least costly and at the same time, of most peace-time use. But partially and fully-embedded shelters are also possible. These latter types would be much less exposed to blast and splinters but since they involve excavation will cost rather more. Further they will look different from normal structures which is not desirable from the psychological point of view of fright and risk upon young minds.



Brick surface shelter erected without timber or steel

It is somewhat difficult to strike a balance as between surface and embedded types of shelters but where strict economy is not imperative and little peace-time service is expected of the shelter, embedded types are preferable.

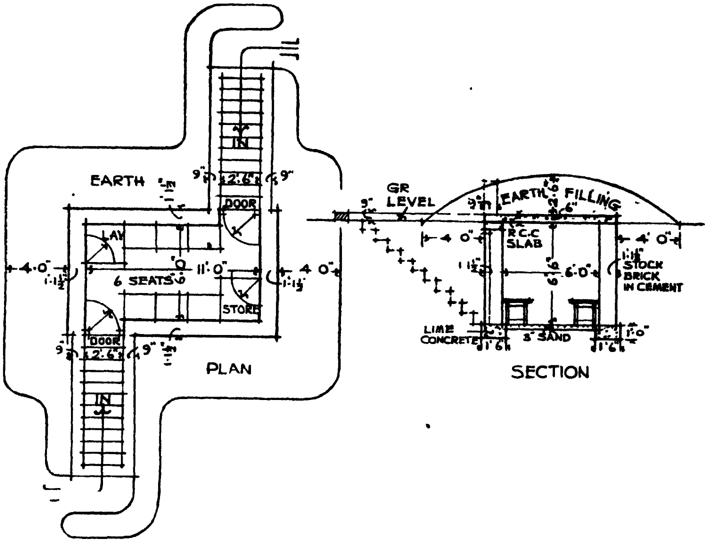


Domestic shelter for 10 persons below ground level

Such partial or complete, embedment will, of course, entail extra expenditure on account of both the necessary excavation and the waterproofing of the walls below ground level.[1] In addition, the

[1] One of the problems of air raid shelters, partly or wholly below the ground level, in Great Britain, is to prevent leakage of water, which manages to find the minutest hole or crevice in the most extraordinary fashion.

provision of properly protected entries and practicable emergency exits is not quite so simple and the peace-time uses of the shelters will be rather restricted as compared with surface shelters.



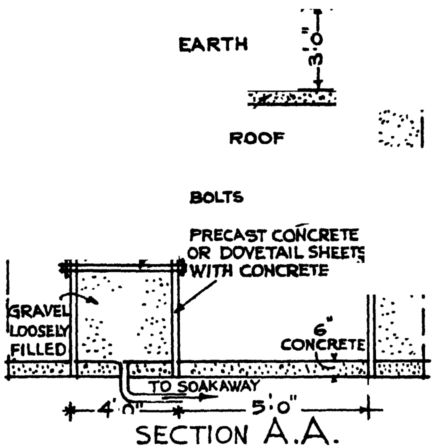
Domestic shelter for 6 persons below ground level

In many parts of England, depending on the nature of the ground, the matter is extremely serious, as covered trenches and air raid shelters are soon flooded to a depth of two or three feet, and pumping has to be employed. In a large number of cases this leakage is due to inferior workmanship, because of gross carelessness and stupidity. For a satisfactory concrete the aggregate used must be of graded uniform size and must be also a hard and satisfactory material, entirely from free clay, loam and organic impurities. No concrete should be made, and especially for air raid shelters and trenches, with less than one part of Portland cement along with two and a half parts of sand and four parts of coarse aggregate.

Use the minimum amount of water in mixing. If any reasonable care at all is exercised on the lines indicated, then concrete, say 6 in. thick will be almost completely water-tight. A good plan also is to daub the outside of the concrete with bitumen, whilst there are available a large number of cement or similar compositions for coating the inside concrete surface. ("Hindu", 28-4-1940).

The astounding pronouncement was recently made by the Ministry of Home Security that all public shelters built with lime-mortar must be closed, as it is now realised that a mixture of lime and sand is seriously affected by the weather. Further, these public shelters ('hundreds of them' is the expression used) have been inspected by constructional engineers, and a pronouncement made that surface shelters constructed with a mixture of lime and sand are not proof against blast from even the smallest bomb dropped yards away. The Ministry of Home Security has ordered that such shelters be pulled down and rebuilt. (*Vide* "Builder", April 18, 1941, p. 392).

Moreover, on wet sites, where the water level is just below the surface, the danger of partial flooding of the shelter at the crucial moment must be kept in mind, although on many sites such flooding is not likely.



Section of a concrete shelter below ground level showing the method of earth covering for the roof

If the entrance to the shelter is situated between 6 and 15 ft. from and facing a substantial wall of the house or work place, that wall will act as a baffle to cut down the blast effect travelling towards the entrance. If it is situated more than 15 ft. away the entrance should be guarded against blast by means of a baffle wall forming a part of the shelter. Or alternatively be similarly protected by an earth wall whose least thickness is 30 inches. The passage running from one end of the baffle wall to the real shelter entrance can be guarded by a door and equipped, if desired, with a gas curtain.

Baffled entry shelters are preferable and twinned and foursome units are advisable wherever possible. For small houses small shelters would suffice but for large houses, shops, small hotels, etc., sizes accommodating 24 would be useful. No specific provision for cross ventilation, other than that likely to arise between the entrance and the joints of the plates and loose bricks of the emergency exit are mentioned in the directions for Domestic Shelters for six persons issued by the Home Office. If desired, however, an air brick aperture can be inserted for peace-time service in one of the walls always, provided adequate measures are provided at the same time to provide a blast-resistant closing device over the air brick apertures, for use during air raids. A plate device similar to that used for the emergency exit would be adequate. In the case of certain of the larger types cross ventilation will be set up naturally by the flow of air between the two or more entrances.

In conclusion we should emphasise that all these shelters offer limited protection to blast and splinters. They cannot stand the direct hit of high explosive bombs of medium weight. Emergency measures cannot be better ; bomb-proof shelters for all the citizens is impossible within a short time due to the heavy cost. To lessen the magnitude of the danger, until existing cities are readjusted with protective accommodation for all the inhabitants, every future residential building should have its air raid shelter, which would give reasonable protection and which will have no adverse psychological effect, upon the minds of children and adults and " entering of which would in war time be no novelty."

Recent bombing experience discloses numerous cases of direct hits upon air raid shelters. " A number of people were killed in cellar shelters " in Malta in May 1941, when there was a severe raid one night. When Clydeside was bombed in May 1941 " a number of people were killed when a street shelter was directly hit." " There were a number of casualties, mainly women and children—when a surface shelter was wrecked " in London in an April night in 1941. When the Nazis attacked Hull shelters were wrecked in the raid and many children were killed.

The worst incident involved a communal shelter in a working class area. There were a number of people in it when the shelter was wrecked. The bomb demolished some surrounding property and debris fell on the shelter completely burying it. Several people were rescued alive but others including children, were killed. A woman lost her three children.

It is natural that people are tempted to stay out than enter shelters.

A census taken in July 1941 showed that 1,04,920 people are using public shelters and 5,56,000 were using domestic shelters, as compared with 4,70,200 and 21,40,000 respectively, in November 1940, while approximately 12 per cent. of the users of public shelters were children.[1] Large shelters, unless bomb-proof, should be small.

As Alderman Charles Key, M.P., declared in a broadcast that in a neighbouring borough to his own more lives were lost "from a single bombing of an underground shelter than we suffered

[1] "Hindu ", 31-7-1941.

by two months of intensive bombing." "We lost," he added, "less than one life for every two bombs dropped."

As Prof. Haldane has made it very clear: 'The truth is that any large shelter, unless it is completely bomb-proof, is more dangerous than a small one.' The moral is that shelters, unless they are really bomb-proof, should either be small or, divided up into small compartments by really blast-proof walls, not thin brick-walls with very poor mortar between the bricks.

"I am certainly horrified at the large size of some of the non-bomb-proof shelters."

"I would much sooner be in a small brick surface shelter than in an underground "shelter" of this kind during a raid. Indeed if I had a steel helmet I would as soon as be in the open air."[1]

[1] "Indian Express", 14-5-1941.

CHAPTER IX

PRECAUTIONS FOR STRUCTURES AND SERVICES

CHAPTER IX

PRECAUTIONS FOR STRUCTURES AND SERVICES

Wherever possible precautionary measures must be adopted to minimise the consequences of air attack to city structures and services: Care should also be taken to protect valuables, records and documents, art treasures and manuscripts that cannot be replaced when once destroyed. Historic monuments should be preserved. Key positions must be guarded.

Art treasures were removed from the Helsinki Museum on the eve of attack. Valuable radium of a London hospital has been deposited in a tube sunk deep into the ground. The City of London has been transformed by sandbags. Underground tubes have been protected against the risk of flooding from burst mains. In every city in Europe anticipating air raid, diverse measures have been adopted. For unless everything is done to increase resistance, collapse would be quick and the consequences terrible.

Regarding city structures absolute protection is out of question. But even precautions are not worth the while for small structures built in the traditional style in highly congested areas especially when they are situated close to important objectives that would invite the high explosive. Every existing building must be examined on its own merit and measures to be adopted should depend upon the type of construction and the quality of the building as well as its location and neighbourhood. For most of the buildings built in local style and which are old and situated in congested quarters with solid masonry load bearing wall no major structural precaution can be taken without practically reconstructing the building. For tall structures like temples, cathedrals, mosques, etc., precautions might prove uneconomic. To multi-storeyed structures of modern design and construction, something could be attempted.

A survey of city structures will make it clear that measures for resistance would be expensive. For instance gas-proofing is almost impossible for structures with tiled roofs and even to terraced

houses which are old. Even painting the walls up to eight feet as suggested for cleansing stations will not be possible for many residences. All that can be done to resist a gas attack is to provide ample water-supply and to make provision for draining away water used for decontamination.

To large commercial premises, government and municipal offices gas-proofing by sealing up the crevices and equipping doors and windows with gas-proof curtains and devices and painting the walls upto 7 or 8 feet with washable paints must be attempted. To restaurants and boarding-houses, to oilman stores and to depots where food grains are stored special precautions must be taken and State compulsion might become necessary. They must be gas-proof and provision for decontamination must be made. As most building materials in use, absorb liquid poison gas, preventive measures would prove uneconomic, and provision for decontamination must be made.

Precautions against Fire

The danger from incendiary bomb attack may perhaps be most severe to congested Indian cities. Even in the West this has proved serious and measures to equip cities with fire-fighting organisations have been made. In London over 2,000 fire-fighting parties are organised. Fire-fighting squads form the necessary complement to precautions that would minimise the risk of fire and its spread. For, adequate water-supply may not be available and immediate attention might not be possible.

There are three methods of fighting, incendiary bombs:

1. To prevent the bombs from reaching inflammable objects.
2. To prevent fires from spreading.
3. To fight fires which have already gained a considerable foothold.

The last method is almost useless while there is water scarcity when fire breaks out wholesale. The second method advocated by the Government of Great Britain in A.R.P.H. 9 assumes that persons are in the house or in the building when the bomb strikes it, that anybody is skilled in the difficult art of fighting the incendiary

bomb and that people do not go into shelter when there is an air raid. These assumptions are hardly true.

1. Houses may be empty, women and children having been evacuated and the men away at work or in military service.
2. The enemy will not announce beforehand whether he will use incendiary or high explosive bombs or gas.
3. Enormous skill and courage is needed and protective clothing is essential to reach the bomb. Many incendiary bombs spray their contents causing many fires at once.

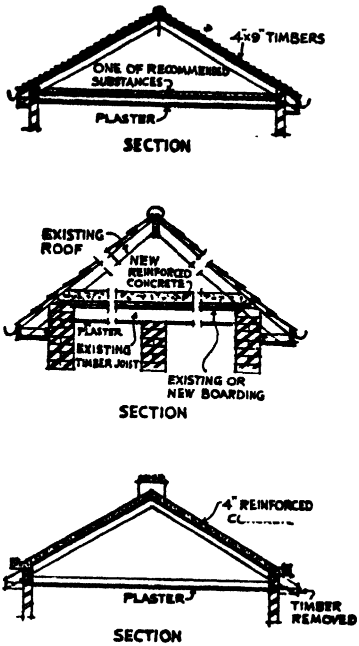
The most effective method therefore lies in preventing bombs from reaching inflammable objects.

Unlike the high explosive bomb the incendiary when dropped from a great height will fall almost vertically owing to air resistance. Naturally they will penetrate the roofs of houses and not openings in the walls.

Structural precaution against fire should take into account the two different effects wrought by the incendiary: 1. The direct destruction to vital structural members. 2. The damage caused by the exceedingly large stresses directly or indirectly due to difference or change in temperature. Although brick walls could never be destroyed directly by fire it would often collapse by the thrust due to the expansion of the beams owing to the increasing temperature. The latter action is more important and dangerous to buildings with timber floors and roofs.

There are two ways of protecting houses and other properties against incendiary bombs. The first is more expensive and assures full. protection while the second is cheaper and will protect 60 per cent. of cases when 2 lb. bombs are dropped. To give full protection to houses with timber roof, the vulnerable parts of the house should be covered with 4 in. concrete or ¼ in. steel or 3 in. concrete and 16 gauge steel sheeting or other material which will prevent penetration. Four inch timber boarding will prevent this but to prevent catching fire it should be covered with asbestos or sheet steel. But even if it

burns it would have stopped the bomb. Any bomb resisting material could be applied to the outside of the roof. Reinforced concrete or protected timber could be used for sloping roofs as shown in the diagram. The tiles may be removed or replaced on the top of the concrete to preserve the original appearance.



Methods of strengthening roofs to resist the Kilo Incendiary Bomb

A flat concrete floor at the level of the eaves is usually cheaper than the above. Incendiary bombs will burn into the roofs but will not affect the residents nor burn down the building. Another method less expensive is to use tight-fitting timber boarding with a double steel plate on top. Two 10-gauge sheets are better than one 20-gauge sheet although the total thickness is approximately the same. Such double sheets supported by 4 in. timber properly anchored to the existing walls will localise the fire on the roof. Asbestos sheeting between these two will prevent damage to timber by red hot steel. Such a protective measure could be utilised to convert the building into a flat roof one, after a fire.

Even two inches of concrete on the outside of a roof steeper than 40 degrees will make most of the 2-lb. bombs glance away or if 2 in. of concrete is used for the attic floor will prevent incendiary bombs already checked by the existing roof, from reaching the floor. Similar will be the result if 2 in. boarding is used instead of the 4 in.

Partial protection can be achieved and the fire localised by attic floors as mentioned in the previous paragraph. But we should remember two additional precautions :

1. The walls must be properly tied together.
2. A layer of fire-resisting material must be arranged on top of the attic or the attic beams in such a way that the presence of an incendiary bomb on top does not result in damage underneath.

Care must be bestowed in choosing the proper fire-resisting material. Steel, kaolin or foamed slag, asbestos, ashes, etc., are mentioned by the Home Office; but the consistency of these materials must also be taken into consideration before using them. Powdered kaolin will be scattered when a missile falls over it and there will be no protection. Steel sheets might be bent upwards by the terrific heat and through the gaps formed, burning material might fall down and set fire to the attic beams. Steel sheeting placed over powdered kaolin will prevent their flying about and also the gaps through which burning matter will come down. Where attics are connected with staircases special care must be taken to prevent fire coming down. The opening should be closed and made part of the floor. A manhole cover should be provided if communication must be maintained.

Flat roofs of 4 inches of reinforced concrete, are incendiary bomb-proof; if hollow tiles are used 2 in. of concrete on top of the existing insulation or asphalt would strengthen it sufficiently. Flat roofs with timber construction with only a thin covering of a kind of bitumen paper or corrugated sheet particularly when old, cannot resist incendiaries. A new reinforced concrete roof is essential. If the existing construction is strong enough which is not generally the case, two layers of sandbag would be cheaper than concrete slabs.[1].

To most tiled houses in our cities these reforms may prove uneconomic and beyond the means of many owners. To many other dwellings these will be definitely impossible, in the slum areas and in poor quarters where thatch is a prominent feature. Organising fire-fighting services and making provision for adequate water-supply and the cutting of 'fire lanes' is essential.

Anti-fire lanes could be made by clearing sufficient space between rows of buildings to prevent an incendiary bomb from breaking out and spreading, as is done in Chungking, and as recently recommended by the Ceylon Government.

[1] *Vide* F. Samuely, the "Builder", November 17, 1939, p. 712.

Regarding high explosive bombs precautionary measures taken should cover, framing, walls, windows, roofs—both flat and pitched—projecting features like parapets, cornices, etc., and gable ends. The main principles to be followed are briefly indicated below.[1]

Precautions against Blast and Splinters

Load-bearing walls are extremely vulnerable to air attack for the blast, by destroying a part of a wall can bring down the whole structure not directly affected in the original explosion. To meet this danger two methods are possible. A frame could be incorporated or constructed within the building. For large masonry buildings an internal framework would prove economical and feasible. But

Blast effect upon buildings strengthened with internal and external supports

for a small one it would be expensive, the cost will be almost prohibitive. A frame could be constructed within the building independent of the enclosing walls. This would carry the floors and relieve the walls of their load-bearing function. It is, however, extremely difficult to design a means of carrying the external walls on this frame without practically reconstructing them. Buildings in partial frames are not common in this country. Where they

[1] *Vide* Oscar Bayne, "Structural Precautions against Air Attack", the "Builder", January 13, 1939, pp. iii–xxxi; E. L. Bird: Conference on Structural Air Raid Precautions, R.I.B.A., June, 1938; J.R.I.B.A., June 27, 1938. T. E. Scott: Conference on Structural A.R.P., J.R.I.B.A., June 27, 1938. "The Indian Concrete Journal", A.R.P. Number, September, 1939. *Vide* also "Structural Damage Caused by Recent Air Raids to some Single-storey Buildings", Bulletin No. C8, Research and Experiments Department, Ministry of Home Security. The examples of the damage given show the need for (1) full framing, (2) rigid steel frame work and (3) "Safety Valve" type of construction, if maximum resistance to collapse is to be obtained.

exist it is easier to complete the frame. The framing required will consist only of columns and beams on external walls which can be linked to the ends of the existing beams relatively easily. In many cases the existence of a wall beam in the external wall will solve to some extent the problem of carrying the wall at each floor level.

There is little that can be done towards making a wall-bearing structure safe from bombing. Sandbag barricades may protect the contents from fragments of bombs detonating outside the structure but they cannot prevent demolition of the entire structure by blast.

Walls in general are 14 to 18 inches thick in this country, and the Home Office recommends 13½ inches in brickwork to resist blast and splinters from 500-lb. bomb of the high explosive type exploding not nearer than 50 feet. Where the walls are thinner they must be strengthened by bonding extra material throughout the length and height. The addition of piers or buttresses at intervals may increase the stability but will not add resistance to penetration.

Sandbagging

Sandbag protection has been extensively used for protecting entrances of buildings, pavement lights, wall openings, the walls of ground-floor shelters, and parts of the walls of basements which are above ground. Sandbags have also been used to a considerable extent in the form of hut-shelters for wardens' posts. Experience has shown that complete deterioration of sandbags exposed to the weather may occur within a few months, and even in favourable circumstances in less than a year.

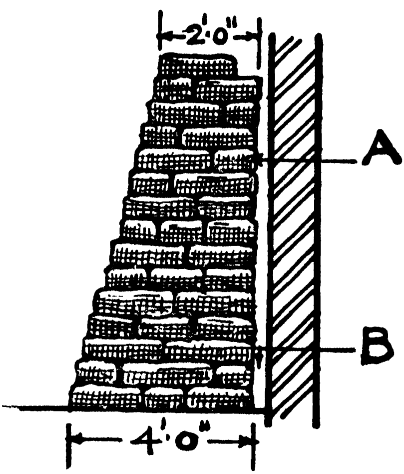
The Home Office requires a thickness of 13½ in. of solid brickwork bedded in mortar, 12 in. of reinforced concrete, 15 in. of plain concrete, or 30 in. of sand or rubble in a revetment. When a combination of these materials is used they must be used in the same proportions; that is, for every inch of plain concrete it is permissible to omit 2 in. of sand. In the thickness mentioned 8 in. of concrete permit the omission of 16 in. of sand. While the actual costs will vary with time and circumstances, it is evident that sandbags do not, in general, provide economical protection and, if hollow concrete blocks are available, sandbag protection will only be the most suitable where the work is definitely temporary.

The Government of India[1] recognise the defectiveness of sandbag walling. The supply of sandbags is also limited. In any case "their liability to deterioration makes it desirable to consider in all cases where protection is required, whether a more permanent structure can be provided; the latter may also often be more economical course." Sandbags are advised only for a temporary need. Where a brick in cement wall 13½ in. thick is not possible, by reason of ventilation etc. the following hints are suggested.

Earth may be used instead of sand, in filling the sandbags. Gravel, ballast, broken bricks and other materials may be used as alternatives to earth or sand. They should be broken into small pieces so that when the sandbag is filled, it can be shaken into a compact and pliant mass.

A preservative should be used to prevent rot in a comparatively short time.

Sandbags should be only three-fourth filled and, when beaten with a shovel to a rectangular shape, should measure 20″ × 10″ × 5″. If the mouth is carefully folded under it when placed in position, it need not be tied.



Correct method of sandbag walling

A sandbag is said to be a "stretcher" when it is laid with its longest side parallel to the face of the wall and "header" when this side is at right angles to the face. The bags should be laid in alternate courses of headers and stretchers, the first course being headers; this is similar to the method of laying bricks which is known as "English bond". Headers should be laid with the tied ends (chokes) inside. If the bag has only one seam, this should also be turned towards the inside in the laying of stretchers. Vertical

[1] *Vide* "Air Raid Precautions Training Manual", No. 1, p. 28.

joints should be broken, that is, the joints in one layer should not be opposite the joints in the next layer above or below.

A brick foundation making provision for drainage should form the base of the sandbag wall to protect it from damp. A sheet of water-proof material such as bituminous felt should be spread under the top layer of the bags, and a similar sheet should be placed between the sandbags and the wall against which they are piled.

The following table shows the number of standard sandbags required per foot run.

For a sandbag wall	6	feet in height	30	sandbags per foot run.
,,	7	,,	35	,,
,,	8	,,	40	,,
,,	9	,,	50	,,
,,	10	,,	60	,,

Thus it will be seen that, for a sandbag wall 9 feet in height and 10 feet in length, 500 sandbags will be required. The sandbag wall should be 30 inches thick at the top and proportionately thicker at the base to allow a slope (batter) of four in one on the outside face.

Where sandbagging is inevitable treatment for rot-proofing is essential. Two types of preservatives are suitable for application to sandbag revetments. They are respectively a creosote or tar distillate, used as a water emulsion, or a solution of an organic copper salt in creosote made up into an emulsion. The former treatment is for revetments in position which have already deteriorated by being exposed to the weather for some time. The latter is more potent but is also more expensive and its use will not generally be justified unless the bags are in good condition and unless it is desirable to take down the whole revetment, treat all the bags and then re-pile them. Creosote must be applied when the sand is dry and treatment should be repeated at intervals not exceeding three months.

These germicides will only protect the outside surface of the revetment, but the rot and decay start in the inside, between the bags. Even if the bags are treated with rot-proofing chemicals before filling with sand, there is still the certainty that the lower bags will burst as weight settles: the seams being so very weak, and seams cannot all be inside.

Drying the sand before filling the bags and then covering the work in timber or felt would probably lengthen the life of the protection, but would be uneconomic and extremely difficult without the proper plant. It is well to remember in this connection, another serious disadvantage, the spread of infection. They are polluted by dogs and cats and become "up-to-date semi-detached residences for the rats of the metropolis," as well as the breeding place for beetles, cockroaches, ants and other kinds of parasites. This may prove a source of infection and spread disease. There is no satisfactory method of preventing decay and the consequent collapse of sandbag protection.

A method of protecting sandbags against the effects of damp has been recommended to local authorities by the Ministry of Home Security. It consists of placing a water-proof cover, for example, bituminous felt, under the top layer of bags, draining the ground at the base so that the pile does not stand in water, and applying either a creosote or tar distillate or a solution of organic copper salt in creosote to the exposed face of the pile.

Local authorities have been advised also to put a kerb at the base of sandbag piles to prevent their being damaged by passing pedestrians. Any holes made in the sandbags through which filling would escape, with a risk of the collapse of the pile, can be repaired with strips of hessian.

The Ministry of Home Security has drawn attention also to the danger from erecting revetments too high. As a general rule they should not be higher than six to eight feet and never more than ten feet.

London is rapidly losing all its sandbags, and the standard practice is now to use brickwork or hollow concrete blocks filled with sand for the protection of windows, doors and similar apertures.

This looks much neater although in some cases the sandbags have been completely enclosed in wooden shuttering. This, however, is not a good method, since apart from not being fire-proof it uses up valuable wood whereas there is abundance of bricks and concrete, especially because of the enormous slump in the building industries. The standard protection can be obtained from 13½ in. of brickwork, 15 in. of concrete, or 12 in. of 2-way reinforced concrete and there is very much to be said for the use of bricks, which requires no steelwork, occupies a very small amount of floor space, is lighter than

concrete and can easily be bonded into existing buildings as a support. Further, brickwork has a definite salvage value.

Thus at Wandsworth the standard method has been for the basement shelters to build baffle walls of 9 in. brickwork in front of the entrance and exits when these are below the ground level, but when above ground the standard adopted has been of a 13½ in. wall generally, at Wandsworth, as in other places, brick protection of this type is considerably cheaper to erect than sandbags, which to give similar protection have to be 2 ft. 6 in. thick, the labour costs being considerable. Altogether the sandbag is in very bad repute and certainly the damp and difficult climate of Great Britain has played havoc with the jute fabric.

His Majesty's Government are substituting hollow concrete blocks for sandbags.[1] In a number of areas a brick wall 13½ in. thick bedded in cement mortar has been adopted. Brick wall in cement mortar is now revealed to be cheaper than sandbagging, by experiments conducted in one of the cities in Great Britain where after investigation the use of sandbags was given up for strengthening public basement shelters.

" The use of sandbags for baffle walls and for the purpose of closing the windows was in principle abandoned right from the start, as a careful investigation into the relative cost of splinter-proof sandbag and brick walls showed that a 13½ in. brick wall built in Feltton bricks in cement mortar, resting on existing concrete with no footings and finished on each side with fair face, would cost between 20*s*. and 25*s*. per yard super, as against a cost of 35*s*. to 45*s*. for an equivalent sandbag wall 2 ft. 6 in. thick, including the cost of the sandbags, sand, labour in filling, tying and placing in position and treating the exposed surfaces after erection with some preservative. This comparison of the cost of brickwork and sandbag

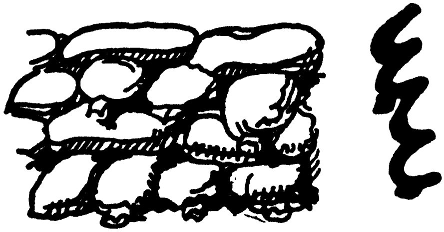
[1] Sandbagging is receiving wide attention and its deterioration has aroused good deal of comment. The Ministry of Home Security have issued a technical circular recommending the use of preservatives. (*Vide* " Hindu ", January 7, 1940). Treatment for rot-proofing sandbag revetment. J.R.I.B.A., November 20, 1939, p. 15. See also Frank Bennett, 'Sandbagging; its defects.' "Builder ", October 17, 1939, p. 613. A. O. Vincent, " Builder ", November 17, 1939, p. 711, suggests a mixture of Hydraulic lime and sand instead. The quest for alternatives like brick walling, hollow precast concrete blocks etc. " Builder", November 24, 1939, p. 741. A. R. F. Anderson—Protecting London Statues. "Builder ", No. 3, 1939, p. 639. Sandbag walling, October 13, 1939, p. 566. Prof. R. V. Southwell, the Protection of Windows against Bomb Splinters, the Pebble Screen. *Ibid.*

wall does not take into account the fact that the sandbag wall will in all probability have to be repaired if not replaced, even when treated, after a period of one or two years approximately. On the other hand, the cost does in neither case provide for removing the walls when the emergency is over. It was anticipated that in such an event there would be very little difference in the cost of removing the two types of wall."

In the narrow streets of our cities the danger of sandbags blocking them in the event of an explosion should be recognised. Some streets are so narrow that sandbag walling on two sides would hinder traffic even in peace time. Further, deterioration would be more rapid owing to the monsoon and the heat. Even in England vegetation, sagging, bulging out of alignment, earth tumbling out, the formation of gaps, have become apparent and the government departments and local authorities have been forced to devise measures to check deterioration and to discover a more permanent substitute for this type of revetment. Sand filling between timber boardings is not considered feasible owing to scarcity of timber. Hydraulic lime free from expansion, mixed with sand in the proportion of 1 to 7 or 8 or even leaner has been suggested. This mixture when placed in position and wetted would set and the whole would then be reasonably stable and permanent and would not collapse even when the bags burst, as the hard contents of each bag would support its share of the weight. It will not be so hard as to increase the risk of richochets and there would be a minimum of splinters, as the hard contents of the bag would tend to pulverize rather than splinter.

This would cost about ¾*d.* extra per bag at the most while the cost of germicidal treatment comes to about ½*d.* per bag.

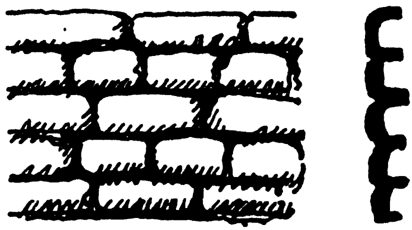
The considerations mentioned against sandbag equally apply to this kind of protection so far as space is concerned and thickening the walls wherever possible is desirable.



Sandbagging (Emergency)

To city statues a revetment of hollow precast concrete blocks may be preferred since they have a neat appearance and the cost will

not be very much more than building a brick wall around. The cost of a concrete block revetment however is approximately half that of one of sandbag type of equal protective value and once erected the concrete blocks require no further protection or maintenance over a long period of years. It is already felt that time has approached for replacing the majority of sandbags in the vulnerable areas of Great Britain, by this method.



Sandbagging (Military)

A common requirement for sand-filled hollow concrete block revetment is that the total thickness shall be 22 in. comprising 8 in. of concrete and 14½ in. of sand; when 18 in. by 9 in. blocks are used, this is met by erecting a double wall with a 4-in. space between the two leaves, which is also filled with sand. The two leaves of the wall are tied together with a wall tie.

The cost of sandbagging compared with that of more permanent construction is indicated by the following figures:

Sandbag Walling

	Per 100 bags *sh.*	*d.*
Sandbags	36	0
Sand at 9*s.* per cubic yard and filling	31	6
Placing	11	0
	78	6

Net volume of filled bags, say, 0.66 c. ft. each. Gross volume, say, 0.85 c. ft.
Cost per square yard of wall = 8*s.* 4*d.* approximately.
Add for weathering to top and timber platform, say, 2*s.* per lineal foot of wall; or, say, for 6 feet height a total cost of 9*s.* 8*d.* per yard super 1 bag thick.

Pre-cast Concrete Hollow Block Walling

	Per yd. sup. *sh.*	*d.*
9 in. by 8¾ in. by 17¾ in. hollow blocks ..	6	6
Sand at 9*s.* per cubic yard	0	10
Laying and filling, say ..	4	0
Total per square yard ..	11	4

Although the above costs show a saving in first cost of about 15 per cent., the cost of hollow concrete block revetment is reduced

when an existing sandbag revetment is to be replaced and the sand on the site can be used to fill the blocks, or for sites where the cost of filled sandbags delivered is 100*s*. per 100, a rate which has been common in some districts. Moreover, it has to be remembered that concrete blocks are permanent, and will cost nothing for maintenance or for waterproofing.

The problem of protecting windows is far more difficult to solve since the measures to be adopted should be devised to suit both the nature of the building as well as the neighbourhood. They could be let alone to function as safety valves in the event of an explosion or they might be protected to resist equally with the walls. Heavy shutters, removable slabs or sandbags are suggested but,

1. In buildings surrounded by wide streets or open spaces and without internal courts the value of protection against external explosion given by protected windows would be sufficiently great to justify the risk of increased damage in the event of a direct hit.
2. In buildings surrounded by narrow streets and with enclosed areas such as light courts and courtyards, the danger of increasing the damage caused by either interior or exterior explosion would be so great as to outweigh any advantages.

In practice protection is obtained by heavy steel or composite sheet steel shutters and units of like construction and it is recommended that if brick or concrete is to be built into position at the time of emergency it is essential that all necessary material should be stored ready for use. It is best to make shutters and removable frames larger than the opening so that they over-lap the brickwork all round. When fitted on the outside of the wall the force of an external blast will be transmitted to the wall directly by the bearing edges and not through lugs or other anchorages. In case of an internal blast the strength of the shutters would depend upon the fixing lugs which would probably fail as we desire if the pressure was great. In either case it adds resistance and safety to structures to protect windows with steel shutters and units larger than the opening and fixed outside.

To poorer class of buildings where closing the window with brickwork would entail difficulty and darkness, a pebble screen made up of a frame containing two flat layers of wire-netting en-

closing a layer of pebbles not less than 4 in. thick might prove useful against splinters. The thickness could be increased to add its resistance. The two faces should be reasonably flat when the frame is filled but able to bulge largely if the pebbles are struck by a flying fragment. Before the pebbles are inserted the two faces should be tied together by stays of thin wire or string, strong enough to prevent bulging under the mere weight of the pebbles (say 80 lb. per cubic foot) but, on the other hand, weak enough to break when the frame is struck, thus leaving the wire-netting free to bulge. The aim of the whole scheme is to obstruct a flying fragment, not by anything strong, and rigid, but by a "cloud" of heavy particles (the pebbles). This cheap device is easy to fit any window, and when filling the frame if a few inches are left at the top and a reserve of pebbles is provided to fill in time of need, daylight will not be shut out. The whole point of the pebble protection is its ability to yield freely, and there must be nothing to resist the bulging of wire-netting if a bomb splinter should hit. All that is needed is a little rough timber, some wire-netting and a few pailsful of beach or gravel pebbles.

Large windows with glass panes require careful measures to reduce the danger caused by glass splinters. The explosion of a bomb can shatter the glass panes of structures over a considerable area as indicated in Chapter I. Every bit of glass has been blown to pieces in long rows of houses by one or two explosions. Considerable attention is therefore paid in England, where large glass panes are used both for residences and for office buildings.

Wherever possible the glass panes should be removed preferably with the frame and stored in a safe place until the threat of air attack passes away. Where such removal is not possible nor desirable measures are necessary to prevent the scattering of glass splinters. Good deal of research in this direction has been carried out by the Research and Experiments Department by the Ministry of Home Security.

Anti-scatter treatment for glass windows is still engaging the attention of the Building Research Station. "Anti-scatter treatment for windows," that is the protection of the glass in such a manner as to prevent injury caused by fragments when shattering takes place because of bombs, is no easy matter. Materials such as transparent film, paper and fabrics stuck on to glass windows

reduces the danger enormously. The products include synthetic resin lacquers, rubber latex, multitudinous varieties of adhesive nets and other fabrics and of strip material.

The Building Research Station have tested up to the present time about 210 different liquid treatments and 220 types of adhesive nets. A general investigation of the behaviour of glass windows under blast has also been carried out on behalf of the Ministry of Home Security. It appears that a large proportion of the rubber latex and synthetic resin lacquer materials are not efficient because the film resulting from a 2-coat application on a vertical window is often too thin. Also in a large number of cases the good results are not retained after a few months because of the action of the weather, the film tending to become brittle, partly due also to the slow evaporation of the residual solvent. Transparent films of the cellulose and cellulose acetate variety give very good anti-scatter protection provided the film is thick enough and that it is applied properly to the glass. Further, almost any reasonably strong textile fabric, such as cheese cloth, muslin or lace netting, will give the requisite minimum degree of protection if stuck properly on to the glass and to the surrounding frames. There has been a great development in the use of ready-gummed adhesive nets. These are mostly of good value, although they have the disadvantages of tending to peel off, and become mildewed when exposed to condensed moisture. The Building Research Station and the British Cotton Industries Research Association are trying to prepare a suitable specification as regards efficiency of adhesion and resistance to mildew.

In mills and factories where condensation is likely to be caused because of a steamy atmosphere all this net fabric on windows should be varnished over, which has the additional advantage that the varnish itself helps to hold the glass in place after fracture. This method is being adopted to a considerable extent on the London Tube Railways and for other vehicles.

The popular method of sticking paper strips on windows does not seem to be of much real use unless the paper used is very strong, say of the cellulose and adhesive cloth tape type, and is also closely spaced.

If indiscriminate bombing should continue glass windows will either have to be enormously reduced in size and application, or will

need to be replaced by unsplinterable glass, consisting of a sandwich of two sheets of glass and a sheet of cellulose acetate or similar material between. Such safety glass, however, is very costly.

As indicated in the A.R.P. Memorandum No. 12 assuming that glass is likely to be broken, window protection should be devised

1. to prevent damage from flying pieces of glass.
2. to exclude weather (wind and rain).
3. to act as obscuration in certain cases.

Wired glass will provide 1 and 2. When used in conjunction with shutters it will also provide 3, inasmuch as the glass remains in the frame even though cracked, thus permitting the shutters still to be used during black-out hours with natural light still available in the daytime. Wire reinforced glass, is a fire retardative and will prevent the spread of fire. It has been approved by the British Fire Prevention Committee and the London County Council.

The British Government's Experimental Building Research Station at Watford has successfully tested three new alternatives to unprotected glass windows. The first is used in place of window glass. It consists of netting, embedded in thick cellulose acetate film which lets in light and keeps out rain. There is a heavier variety to take the place of north lights, roof lights or other glass on which there is a heavy strain. It equals quarter inch plate glass in strength.

A third device is a lighter form of cellulose netting fixed to window panes by adhesive. A square of plate glass covered with this netting was put under a spring-loaded hammer which was brought down upon it, travelling one-eighth of an inch beyond the point of impact.

If glass is essential the substitution of plain glass by wired glass should be considered. Glass reinforced internally with wire-netting offers considerable resistance to glass. War-time Building Bulletin No. 1, " Treatment of Windows " considers it " desirable to use wired glass whenever possible, since this has been found, by experiment to offer high resistance to blast from a nearby high explosive bomb." Glass reinforced internally with wire-netting offers considerable resistance to blast. Although the glass gets fractured by blast from large high explosive bomb exploding in the immediate neighbourhood wired glass screen is damaged, but does

not splinter and cause injury to personnel. The pieces are held together. In one factory large areas were exposed to flying fragments in addition to blast. Although splinters penetrated the blast the panes remained in the window openings.

Although the problem is less serious in our country especially in residential areas it deserves attention since many modern buildings erected on western model have many large window panes.

Projecting features should as far as possible be removed since they would be dislodged by blast or flying fragments. Otherwise they should be either anchored down or stayed at short intervals. Cornices are particularly dangerous and it is almost impossible to strengthen them in any way. Small ones may be allowed to remain but those with large over-hanging projection should be either removed or cut back to a new profile. Hoods, porch-roofs and other non-structural projecting members should be adequately anchored down if they cannot be rémoved.

Gable ends are extremely dangerous, and liable to be blown away by blast or drawn out by the suction wave, after an explosion. If they are of brick, or concrete, gable ends should be both buttressed and tied to the structure. " If an internal partition abuts the wall below the gable, it may be carried up into the roof space and toothed into the brickwork of the gable to provide good buttressing and a reasonably good tie."

Regarding roofs nothing more is advisable than what was suggested in the previous section to resist the kilo incendiary bomb. Attempting to stop the high explosive is not worth the while ; both terraced and pitched roofs should be dealt with as indicated.

To modern storeyed buildings precautionary measures to minimise the dangers of collapse of upper floors are necessary. Support by planking 2 or 3 inch thick at about three inch interval also supported at suitable centres by beams and pillars is necessary. The planking should easily be fixed close to the ceiling but should not be wedged up tight so as to take the initial impact of the falling debris.

A careful examination of each structure is essential to determine the kind of precautions to be adopted but a survey of city structures

is needed to choose those that would repay the trouble taken and those that deserve to be preserved. This has been stressed by experts and technical advisers as well as by the Home Office of Great Britain, in the interest of economy. In a poor country like ours this is vitally necessary to prevent waste of resources particularly in times of war when the demand for them is greater.

Buildings and structures in Indian cities might be classified as follows :

1. Middle and poor class residences, small buildings and structures, most of them built in local style.
2. Large buildings, residences of the well-to-do, shops and business premises built in local style.
3. Multi-storeyed structures and large residences of modern construction and design.
4. Factories, and Producing Centres.
5. Temples, Cathedrals, Mosques, Art Galleries, Museums, Libraries, Civic Buildings in the old style and city embellishments.

As already pointed out the first group do not warrant expensive precautions, particularly if they are situated in congested localities. Even fire-proofing the rafters by suitable paints would be beyond the means of most owners and the best alternative is perhaps the organisation of fire-fighting services. Most buildings in the next class possess splinter-proof walls but blast-proofing is impossible since incorporating a frame may not be feasible, especially to one and two-storeyed buildings. The next class deserve possible measures which could be undertaken. Most of the measures suggested in the opening pages could be tried but congested surroundings would reduce their efficacy. Narrow streets and packed surroundings might render most measures useless by inviting the high explosive bomb.

Precautions for Factories

For large establishments of the factory type with few exceptions it is not feasible to provide protection in factories against a direct hit from a high explosive bomb. A direct hit, however, is not so dangerous as is imagined. In well-built premises there is

very little danger of serious structural damage from a near miss. The standard of protection should, therefore, aim at the provision of air raid shelters for persons working in the factories and their vicinity ; and local protection of plant against damage by blast and splinters and adequate fire-fighting arrangements.

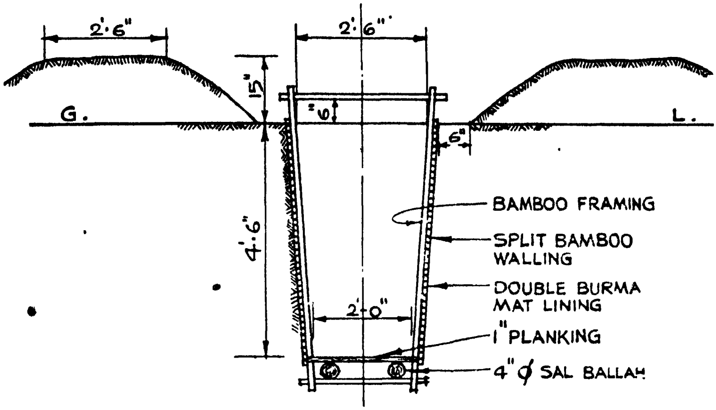
With the increase in the weight and explosive capacity of bombs carried by air-craft in recent raids, the 13½ in. brick in cement wall recommended to protect personnel and machinery in factories is considered insufficient owing to the disruptive disintegration caused by deeper penetration of the heavy explosives. Considerable earth waves have been created and in order to increase protection, strong walls are suggested with sufficient footing, the reinforcements running down into them. Where stronger walls are desired, it is advised that the 13½ in. brick wall should be demolished and a new one built instead of attempting to strengthen the existing baffle walls.

Air raid precautions in factories should embrace measures for the protection of employees since their stay within the premises and uninterrupted work is essential in the interests of production in times of war. How protection can be given to employees and especially those who continue to work after an air raid warning has sounded and are always liable therefore to be surprised by the sudden falling of a bomb is given in Air Raid Precaution Memorandum No. 16 " Emergency Protection for Factories ". The general custom throughout England has now very rapidly reached the stage of continuing to work until the aeroplanes are actually overhead, or guns are in action.

A valuable method is to build small dividing walls only 2 ft. 6 in. high behind which the whole of the staff can lie down in an emergency, thus giving a considerable degree of protection. Further, a series of pits and sub-floor ducts is advisable, in which workers can take refuge immediately though only a short walk of a few yards from the machines.

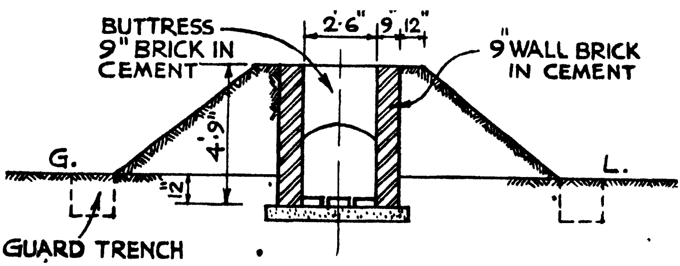
The Government of India, in their " Summary of Air Raid Precautions Applied to Factories," recommend trenches lined with split bamboo-walling, and mat-lining are advised where the ground is waterlogged or low-lying. Another type of trench is that erected most of the part above ground level in 13½ in. wall of brick

in cement and suitably buttressed and earth piled on the sides as advised. A wall shelter protected by 13½ in. brick in cement



Section of trench shelters lined with split bamboo-walling

wall like the lean-to is also suggested, where other methods are not feasible. An open cellar trench is considered suitable where the



The above-ground brick wall shelter

available space is restricted. In all these, the following considerations are emphasised :

1. accessibility both from the point of view of location of the shelters in relation to people using them, and ease of entrance to the shelter itself ;
2. provision of ample space for the number of people to be accommodated ;
3. ample air space per head of the occupants in the case of covered trenches.

Plants should also be protected. Sometimes, a comparatively trivial damage may suspend production for days or weeks. The most vulnerable points are the water; electricity and gas supplies and essential machinery, in their order. All vital plant, including in particular electrical equipment, such as switch gear and transformers, generating plant, and its associated equipment, steam boilers, and any machine or other item of plant which cannot be either readily repaired or quickly replaced should be protected against blast and splinters by the provision of traverse walls.[1]

It is not as a rule necessary for these traverse walls to be any higher than the machinery they are designed to protect. Traverse walls should be so located that they will not impede production or unduly interfere with the flow of materials in the factory. Normal operations should not be interfered. In many factories, machines, fixtures and materials being manufactured can be arranged to give a considerable degree of protection and replace traverse walls.

Windows and door openings should wherever possible be bricked up to the height of the machines or traverse walls erected outside the openings to the same height.

Measures to minimise loss and dislocation to the various components of the factory and the materials handled are also essential. The dispersal of all spare gear and duplicates of machinery is needed. Spare parts should be stored more than 100 feet away of the machines for which they are provided. Telephone switch-boards and other places essential to communication and control should also be treated as vital plant. Arrangements to deal promptly and quickly with damage to machinery and property should also be made.

All unprotected glass is a great source of danger because of splinters which they may give rise to. Glass splinters can get into bearings and moving parts of machinery and shut down vital plant for weeks at a time. All glass should be removed from windows, doors and lights wherever possible. Where this is not possible, it should be protected by ½ in. wire mesh securely fitted on the inside of the glass.

[1] For detailed specifications, refer to "A Summary of Air Raid Precautions Applied to Factories" published by the Government of India, Department of Labour.

Precautions to deal with fire existing under normal conditions should be greatly augmented in times of war. New methods of incendiary bomb attack result in a considerable number of bombs falling in a few square yards instead of being scattered over a considerable area as was the case with older methods. Water-supply may get disturbed, because iron water-mains are particularly vulnerable and can be fractured by the earth wave from a bomb falling a considerable distance away. Each factory should be made self-sufficient in the provision of emergency water-supply.

Inflammable materials in the premises should be cut down to a minimum. Timber and other materials should be stacked in a number of heaps with wide spaces between. Water tanks capable of holding 10,000 to 15,000 gallons should be dug or erected near danger spots. Sprinkler systems and connections should enable a trailer pump to pump water into the sprinkler system in times of war, since a high explosive bomb may destroy the water-mains supplying the sprinklers. When any quantity of oil is present on factory premises, suitable earth bunds should be erected to ensure that the oil, if set on fire, cannot escape and run about the factory. In addition, the organising and training of fire parties with regular fire drills is absolutely essential.

Most, fully steel-framed single-storeyed factory buildings are highly resistant to structural damage by air attack. It was originally felt that, where buildings of this type received direct hits, damage was usually confined to the roofing material, the structural framework escaping undamaged. Cases have later occurred, however, in which a chance hit close to a stanchion has uprooted it, bringing down a portion of the roof steel-work. Interference with production has then been much more serious than where the damage was confined to the roof sheeting. Where structural collapse has been limited to that portion of the roof carried by the damaged stanchion, the amount of steel work destroyed has been comparatively small. Sometimes the collapse has spread and involved a whole line of trusses, and several hundred tons of structural steel have been irreparably damaged. Such collapses are very serious, involving not only considerable loss of production, but also heavy calls for new steel work.

In new factories the danger of this spreading collapse, could be avoided if suitable designs are used, such as those recommended

in War-time Building Bulletins Nos. 1 and 4 issued by the Research and Experiments Department of the Ministry of Home Security, Great Britain. Certain existing factories are, however, singularly liable to spreading collapse, and it is essential that this danger should be eliminated. Fortunately, the necessary measures are comparatively simple and the steel work required to make existing factories resistant to collapse represents only a minute fraction of that which is otherwise liable to be destroyed.

Precautions for Temples, Palaces, etc.

It is very difficult to preserve the miscellaneous group from destruction but they cannot be abandoned for obvious reasons. Against direct hit no protection is practicable to tall structures and monuments, as the expert committees which studied the problem of protecting Cathedrals in Great Britain feel. The Guardians of the Westminster Abbey and St. Paul's Cathedral are therefore focussing their attention to fire-fighting measures. The Building Committee of the Liverpool Anglican Cathedral after careful consideration as to how the Cathedral could be protected from air raids have "decided to leave the building as it is and hope for the best." For, protection "would involve an outlay which the Committee did not feel themselves justified in facing." Their view is that if the worst happened, it would cost less, to replace shattered glass and its stone framework, than to enter on an extensive protective scheme.

Over 2,000 churches have been destroyed or damaged in Great Britain by air raids. St. Paul's did not escape Nazi attention. Over £3,50,000 worth of damage was inflicted on Westminster Abbey. The loss to the nation is immense.

The measures adopted by the Dean and Chapter of the Westminster Abbey however indicate what might be done to preserve as much as possible of the invaluable contents of Cathedrals. Some have been removed, others have been preserved in place and protected, while some others have been left to take care of themselves. For instance the unique thirteenth century retable, the coronation chair, the contemporary portrait of King Richard II, and the splendid series of early bronze effigies together with a number of smaller objects including manuscripts, have been moved to a safe refuge. The shrine and the royal tombs which surround it have

been enveloped with sandbags. The mosaic pavement of the presbytery has been covered with a layer of felt on which heavy timber (3 in. by 9 in.) has been laid and these monuments are considered reasonably safe from anything less than a direct hit.

Tall canopies present considerable difficulty. The body of a tomb can be sandbagged; but the elaborate tabernacle work supported by slender piers may not be able to bear a heavy load. Adequate protection can only be given in such cases by the erection of a special protective structure.

In a great church, there will be many beautiful works that will have to take their chance. For instance the censing angels in the corners of the transept, which adorn the more or less inaccessible parts of the fabric, could hardly be given effective protection.

The crypt of the Chapter house has walls nearly 18 feet thick; and it was planned to convert the stone vault into a shelter for the staff. Many temples in our country possess strong rooms and stone vaults which could shelter both people and valuables. If there is risk of air raids the most advisable thing is to remove all valuables that could be removed, to places of safety. Wall paintings and carvings can be protected to some extent but it is very difficult to assure safety. Old records, ancient plates, etc., should be removed. Weaker parts of the building should be strengthened.

All valuable glass should be removed preferably with their frames to a safe place for the duration of war. Experience shows that they are most vulnerable to bombs and blast. When the famous church of St. Martin's-in-the-Fields was bombed, a bomb tore a hole in the church pavement and all the windows on one side of the church were blown in or damaged. The wall was pitted with splinters, and the office next to the crypt was damaged. The figure of Christ in the great stained glass window over the altar was decapitated, and holes were made in the figures of the adoring Apostles.

When a bomb exploded in St. Paul's, masonry was flung about, damaging statuary and hitting walls. Practically all the windows of the Cathedral were destroyed.

The problem of how a church or temple that has been damaged should be treated is equally important. The very most that should

be attempted is to render the fabric safe and weather-proof in order to preserve what remains intact. A broken roof or shaky wall would call for immediate repair, and if there has been a fall of masonry, special attention should be paid to any carved features (bosses, capitals, corbels and the like) which may have come down with it. All debris should be cleared away. All measures necessary to enable services to continue where these are possible, should be of a temporary character, pending the time when proper attention can be given to the matter.

It is necessary to have good photographs of the views and details of all monuments and historic buildings for they might be destroyed in a severe raid.

In the Indian temple the Garbagraha usually consists of strong walls and ceiling. They could be rendered bomb-proof. The Vimanas could be converted into hemispherical domes resistant to the direct hit of the high explosive and the walls of the Sanctum could be thickened to ward off glancing blow and explosion. This is not beyond the finances of temples in India. But to the tall Vimanas in Northern India and the magnificent Gopurams of the South, protection against direct hit is impossible. Only balloon barrages and anti-aircraft guns could secure chances of escape from destruction.

These measures are also necessary for the numerous historic monuments in vulnerable areas. The Palaces of Indian Princes need special attention, not merely because they form part of India's architectural treasure but also because they form the abode of the rulers of a third of this vast country. To these large structures no one measure will suffice and a scheme of precautions should be planned after careful survey.

The protection of many a historic building is impossible, but it is within our power to make a record which will mitigate the loss by preserving the design for posterity. A set of measured drawings, a collection of careful sketches, or a series of well-taken photographs can do this and keep even the atmosphere of the building in being for future generations to study and admire. Such records are also invaluable if repair, restoration or reconstruction is ever thought of as advisable.

The first need is a list, in each district, of the buildings which are worthy of record. The second is the collection of information

concerning existing records, whether in public or in private hands. The third, which though last in order is the most pressing, is the immediate preparation of records of such buildings as have not been adequately photographed or recorded by drawings.

The Government of Great Britain has taken keen interest in historic buildings and architects have been appointed whose primary duty is to attend on any building of architectural or historical interest which may suffer from enemy action, and direct the work of the demolition squads with a view to preserving everything of value.

The Central Council for the Care of Churches has started a campaign to secure photographs of all parish churches. The National Buildings Record has been formed to collect and prepare records since enemy attacks are mutilating and destroying English architecture.

The Press in Great Britain has given welcome publicity to the need for records. Through the Royal Photographic Society an appeal was made to local societies and clubs. Local record committees have been set up, and already, those for Berkshire and Hampshire are functioning efficiently. The whole photographic strength of the country was proposed to be mobilised for this urgent work.

The following agencies could be mobilised in India for assisting the work of record:

1. The Archæological Department.
2. Museums and Libraries.
3. Architects and Engineers.
4. Government P. W. D.
5. Temple Authorities.

Many architectural treasures in India are irreplaceable and this effort of collecting and making record is essential.

Precautions for Museums, Libraries, etc.

Every possible measure should be adopted to ensure safety to the irreplaceable records of the Government and the public, their gold, silver and valuables, as well as to the Museums, Libraries and

Art Galleries. All these are generally located in the heart of large cities extremely vulnerable to air attacks.

The British Museum in London was damaged in an air raid and thousands of books have been destroyed in and around London when many libraries were destroyed by bombs.

Irreparable losses were suffered by the Royal College of Surgeons in Lincoln's Inn Fields in London from damage in recent air raid. Thousands of museum pieces are gone including skeletons of kangaroos brought by Captain Cook from Australia and a comparative osteology collection of 4,000 specimens acknowledged to be the finest in existence then. The invaluable army medical war collection, containing plaster casts of every type of wound, was also destroyed. Many libraries have suffered badly on the continent.

Three methods are available for protecting art collections in museums and art galleries.[1] Material might be protected in place or transferred to safer storage on the premises, or removed to repositories elsewhere. The policy to be adopted depends upon the nature and value of the collections, the design and structure of the building, the risks to which the locality is exposed and the alternative accommodation and means of transport which are available. In most cases it will be found expedient to divide the risks by adopting protective measures of all three kinds.

Only the most valuable should be evacuated, for packing, transport, etc., may be difficult at the outbreak of hostilities. Secondly, this is possible only if the repository chosen is definitely less exposed to air attack than the original premises. Even slight vibration will harm certain pictures and are better left in their place.

The repository should be at a safe distance (not less than two miles) from any aerodrome, factory, railway junction or other place likely to constitute a target for air attack. Caves or disused railway tunnels, ought not to be used for books, pictures or works of art in any way alterable by damp, though they may serve to shelter certain classes of ceramics, sculpture and the like. Country-houses or public buildings, situated in the localities remote from danger of air attack are most desirable. But attention should be paid to :—

[1] *Vide* Air Raid Precautions in Museums, Picture Galleries and Libraries. Printed by Order of the Trustees of the British Museum.

1. the control of access, security of doors and windows and invigilation.
2. proper ventilation and freedom from damp.
3. fire-fighting arrangements.

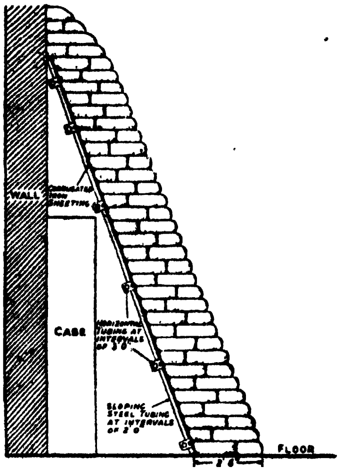
Great attention is necessary during transport and in packing.

Care should be devoted when packing museum material. They are so various in kind that no particular rules for packing them can be given. They should also be rendered damp-proof during transit and water-proof lining is essential for cases containing books, manuscripts, prints or drawings. As far as possible evacuation of pictures should be avoided if transport would harm them.

The most important movable material which cannot be evacuated should be assigned to places of greater security on the premises. There will generally be rooms which have a sheltered situation and strongly built or capable of effective reinforcement. The rooms selected should resist blast and splinter and incendiary bombs. They must have better protection against fire and danger of flooding or other damage from broken service pipes. Good ventilation and freedom from damp are necessary for perishable materials, like paper, vellum, and leather, paintings, textiles, wood and unfired clay; ethnographical specimens other than those in stone, metal or fired clay; natural history specimens with the exception of most fossils, and some minerals; bone and ivory; corroded metals, and terracotta or stones impregnated with hygroscopic salts.

Humidity, temperature and ventilation should be taken into account when selecting the storage room, particularly if it happens to be a basement. Floors and fittings should be fit for storing them. Library material must not be left in closed boxes. The method of storage is of vital importance for pictures. Atmospheric condition in the storage room should be capable of being controlled if furniture should be stocked. On account of the inflammability of spirit and the fragility of the glass containers which are normally used, the protection of natural history specimens, preserved in spirit, presents a special problem. Elimination of bottles is desirable and one container might be used for the contents of each cupboard or room. It is necessary to plan in detail all these, including the method of removal and the means of handling material in bulk.

The third method is protection in place. Entire evacuation or removal is impossible and in most museums this would be necessary. Rooms containing objects which are too numerous, too large or too fragile to be removed must be given such protection as is practicable and the material should be moved as far as possible to the safest parts of the room. Bookcases, pictures and other objects may best be protected by sandbagging as shown. But it should be solid enough to bear the shock of falling roofs or girders. Care also should be taken not to introduce a heavier weight of protective material than the floors can bear without strutting or other reinforcements in the rooms below. The bags should be filled with foamed slag to reduce the weight. Sandbagging should be made so as not to affect ventilation. Chemical units may also have to be used to regulate humidity.



Sandbag protection for pictures, bookcases, etc.

Large objects such as statues or architectural features may be dismounted, laid in the angles of floors and walls covered with asbestos wool and shielded with sandbags laid on a supporting framework. But it is undesirable to use wood in the supporting frames since they are combustible.

Large paintings may be similarly screened with sandbag walling. A limited amount of protection can be given by hanging mattresses in front of them. If it is covered with sheets of corrugated iron or of steel and asbestos composition it would offer increased protection. Vapour gas does not affect pictures but liquid gas splashes cannot be decontaminated. Glass-fronted show-cases can resist liquid gas but will not withstand shock of an explosion or the heat of an incendiary bomb. But it is better to shield all such objects which are not protected by sandbags, with fire-proof and water-proof covers.

If bookcases are kept as free as possible from air-spaces damage by fire may be lessened. Books which cannot be removed to safe storage should therefore be packed closely on their shelves, and the empty spaces should be filled with asbestos, pumice blocks, bricks, bags of foamed slag, or other dry and fire-proof substances. Projecting galleries should be emptied and books must be carried to cases on the floor. Books and manuscripts will quickly absorb splashes of liquid gas, and their decontamination, if at all practicable, could only be effected by expert laboratory treatment. They must be wrapped in transparent foil (cellophane) or waxed paper wherever possible for single books. There is no reason to suppose that gas in vapour form will damage books or other library material.

Evacuation offers the best security from bomb destruction and wherever possible it must be adopted. The trustees of the Indian Museum, Calcutta, already decided to remove some of the valuable irreplaceable articles to some other safe place, as a precautionary measure against possible air raids.

The art treasures in the Victoria Memorial, Calcutta, numbering about four thousand, which have so long decorated the public and special galleries in the different chambers of the Memorial to the delight of visitors, were removed to a place of safety. The work of removing pictures, albums and other exhibits from their original position and placing them in safety was carried out according to plan.

With the declaration as an emergent area, all Government offices and other institutions in the city of Calcutta were directed to take necessary steps for the preservation of important records and for making other incidental arrangements. A waggon-load of the important records of the University of Calcutta was sent out of the City to a place of safety, with the advent of the Japanese entry into the war. These records included a large number of documents which belonged to the days of the inception of the Calcutta University.

Several private and public offices, too, in London sent their very important documents and records to less vulnerable places, and many business concerns in Indian cities have done likewise shifting their head offices to interior towns.

The baffling problem in evacuation is the availability of suitable places for housing records and valuables. Fortunately many

interior towns in India are fairly large and suitable buildings should be requisitioned by the Government both for housing their valuable records, and gold and silver, as well as those belonging to private concerns and individuals. Existing structures in interior towns should be selected with care and suitably improved to make them fit to house such valuable records and material. Adequate police protection may also become necessary to ensure safety.

Schemes for evacuation should be planned and carried out in advance since in an emergency transport facilities may become inadequate.

Protection of our art treasures, valuables and irreplaceable records becomes a great problem largely because of the design and construction and location of museums, libraries, record offices and banks. The task of evacuation and safe keeping would be facilitated if important structures in the mofussil towns were built with strengthened strong rooms or basements.

Even if important structures in interior towns had been designed and built with care evacuation should be considered a temporary expedient only for the various reasons already explained. In the interest of security and economy, in the years to come, immediate steps should be taken to equip museums, art galleries, libraries and record rooms with bomb-proof accommodation, preferably over-ground where space is available or in basements sufficient to accommodate their contents in times of need. Considerations of economy cannot apply to these irreplaceable objects but a dual purpose design could be evolved which will meet even this exacting condition.

Bombing might damage and destroy the cages containing wild animals in city zoos and will let them loose. This might cause danger and panic. Zoo animals, especially wild and venomous ones, should be sent away to places where they could be kept secure for the duration of war. Even other animals might be injured and it may also become difficult to feed them during days bombing becomes serious. Proposal for evacuation of animals has already been made by zoo authorities in one city in India and their example should be extended wherever zoos exist in vulnerable zones.

Statues in cities are also liable to damage and destruction. Those which must be protected should be removed to places of

safety. To others, sandbagging suggests itself. This was adopted for four statues in London by the Office of Works (Charles I at Charing Cross, Charles II at Chelsea Royal Hospital, James II, outside the Admiralty and George II at Greenwich). Apart from the difficulty of sandbagging tall ones such as equestrian statues, the disadvantages already mentioned renders this method unsuitable. The recent remedy adopted in London could be copied. Hollow concrete blocks could be used to cover the statuary to offer protection from blast and splinters without occupying undue space alround, in crowded parts of a city.

Precautions for Services

A successful scheme of evacuation would minimise the strain on the supply of services essential for maintaining the community. Yet in the interest of the many who must live in vulnerable zones they must be guarded from destruction and dislocation. As described in Chapter V, water-supply, lighting, telephone, telegraph and communication, transport facilities, food supply and drainage etc. should be maintained. Their destruction would render life in the area impossible. The Government of Great Britain insists that public utility undertakings should adopt " such measures as may be specified in the notice to secure that the factory premises, mine or as the case may be, any of the premises of the undertaker, can be made less readily recognisable by air-craft in the event of hostile attack.".

The Civil Defence Act, 1939 draws special attention to the safety of railways, docks and harbours as well as electricity undertakings and the State grants half the expenses incurred for measures adopted to safeguard them.

" There may be paid out of moneys provided by Parliament towards approved expenses of public utility undertakers in taking measures, whether before or after the passing of this Act, to secure the due functioning of their undertaking in the event of hostile attack, grants not exceeding one-half of those expenses."

These grants are in respect of measures to secure the due functioning of public utility undertakings. These are further subjected to obscuration of light in the interest of safety. Even in India soon after the outbreak of hostilities in Europe, police guards were placed at aerodromes, electric power-houses, sources of water-

supply, etc. Camouflaging is insisted upon in European countries and the State will provide expert advice to those compelled to adopt it in the vulnerable zones of Great Britain.

Numerous instances of the break-down in the supply of essential services due to bombing have been reported from the areas subjected to air raids. People have been deprived of water and gas in the towns blasted by Nazi bombs. Communal kitchens had to be set up and food supplied free to bombed areas. Transport services have been disorganised by debris and craters in roads, by damage to buses and trams, and by the break-down in electricity. The break-down in water-supply effectively contributed to the break-down of resistance in Singapore. To quote General Gordon Bennett, who commanded the Australian forces in Malaya "Lack of water, incessant bombing and the greatly superior numbers compelled the troops to surrender. At that time two hospitals only had enough water to carry on for another 24 hours."[1]

The opening raids on Rangoon scared the menial servants of the Municipality and the Hospitals that scavenging and other municipal services were affected during days following the raid. Tending patients in hospitals also became difficult.

The transport system was dislocated in Alexandria by air raid since the panicky population hurried to leave the city by thousands.

Already the possibility of air raids are reported to have caused a rise in the price of meat and to its scarcity, as live-stock are not brought into the city as before.

Restaurants and hotels may be closed causing hardships to male members who have evacuated their families as a measure of safety. Government had to compel their owners to keep their premises open, in Singapore. Suggestions for opening up depots for food articles which would function during and after air raids have been made in Madras.

The protection of water-supply, the maintenance of drainage, the preservation of transport facilities, lighting, scavenging and law and order, the supply of food-stuffs, etc., need various measures which must be concerted after a careful study of the individual problems under expert guidance. No general measures can therefore be suggested. The structures used in connection with these essential services should be protected as suggested in the preceding

[1] "Hindu", 26-2-42.

sections. Since it is essential that these structures should remain unhurt effective camouflage measures should be adopted to assure their functioning.

Water-supply could be immunized by making it independent for every building or groups of buildings either by reviving the system of wells and opening them up where possible or by a system of tube-wells all over the town as is being proposed in Calcutta to some extent. This will provide urban folk with protected water-supply. The problem of underground drainage is more difficult to solve especially where the flush-out system has come to stay. Several towns do not possess underground drainage and the cess pit in use could be reformed and retained. In the residential areas of cities some similar system must be devised and the magnitude of the task will be greatly minimised by planned evacuation. These may prove useful to hold the water used for decontamination and would help to prevent the spread of liquid gas contamination. In important commercial areas the underground drains must be protected by concrete road surfaces that would prevent penetration by bombs. Allied to this question is the problem of flooding and other consequences of shattered mains and precautions must be adopted to prevent this effect endangering life in the locality.

The Madras Government recognise that " in the event of any air raid, damage may be caused to water-mains, supply pipes or fittings " and remind consumers " that the water-supply within their property including pipes, tanks and fittings, is the responsibility of the owner or occupier of the building. The responsibility of the supplying authorities is limited to the water-mains and pipes upto and including the outside stop valve on the communication pipe in the street.

" Consumers are advised to make themselves familiar with the position of the stop-cock on the service pipe inside their premises so that they can shut off the supply in an emergency.

" In the event of the temporary suspension of the water-supply the water in the storage tank, if there is one, should be sufficient if it is used very carefully for a day or two. If this water is used for drinking purposes it should always be boiled before use.

" It is of the greatest importance that consumers should do their utmost to economise the use of water during and after an air raid,

as large quantities may be required for fire-fighting and decontamination."

Suitable centres have been selected in vulnerable parts of the city with a view to temporarily accommodating, feeding and sheltering people who may be rendered homeless in the event of air raids.[1]

A thorough overhaul of the water-supply system has been recommended by the Chief A.R.P. Officer to the Government of India, for the city of Karachi.

Lateral protection for vital services such as waterworks and drainage systems from the risk of air raids has been insisted upon the Karachi Municipal Corporation by the Sind Government. The special A.R.P. Committee estimated that it would cost about Rs. 80,000.

It has become evident that coal shortage might seriously hamper the working of the pumping stations in Calcutta. As a precautionary measure these questions must be investigated and proper provisions made in advance since transport facilities may not be available during emergency.

The most essential precaution, however, for maintaining water-supply and drainage is the keeping in readiness of squads who would repair without delay the destruction that might be caused to the water-mains, filter beds, and tanks. Measures to house the Municipal servants associated with scavenging and other services at a safe distance outside the city where they could live and come to do work in the city are equally vital.

Electric power-houses, telephone exchange, telegraph stations, etc. should be protected by suitable measures, at least to prevent blast and splinters of nearby explosions, damaging the structures. Measures to prevent the destruction of machinery could follow the procedure recommended for factories. Here again camouflage assumes special significance.

The Indian home could be made self-reliant by reviving the oil lamp but where electricity is used for power, dislocation is inevitable unless other sources are improvised for emergency. Attempt should be made to decentralise sources of production so that when one of them is destroyed, others might function.

[1] *Vide* "Hindu", 29-8-1941.

Special precaution should be taken for restaurants and boarding houses as well as grain stores and food depots and markets. By State compulsion the premises must be strengthened and rendered blast and splinter-proof. Wherever possible these large stocks of grain should be removed to less vulnerable spots.

By suitable arrangement stocks could be brought into the cities whenever necessary. The cattle supplying meat and milk should also be removed to safe places within easy reach of city zones and arrangement should be made to supply these to the city every day.

All these require an efficient transport system which will stand air raids and continue to function, not merely supplying the necessaries of life to the residents of raided areas but also provide them with conveyance facilities. It is necessary to reorganise and protect the transport system—the roads, the railways, buses, and other vehicles, and railway trains and stations. The precautions mentioned in Chapter V should be given careful consideration and introduced wherever possible.

Roads are liable to be blocked by debris. Debris clearing squads should be kept in readiness to attend to this problem. Bomb craters might obstruct traffic. They should be filled up immediately. It is suggested that small gangs should rapidly patrol a defined portion.

They will receive and await instructions as to where they should go to reinforce another gang. Craters may be of such size as to render the street impassable for ambulances or fire-fighting vehicles. It seems desirable that before any attempt is made to provide an ordinary road crust or even one which is temporary in the usual sense, the holes should be filled to within a few inches of the road surface with a material which can be kept ready in sufficient quantities and is easily handled. Highly porous material, such as hard core, should not be used where water in considerable volumes might flow into the crater before a water-proof crust could be provided. The materials provided should include a relatively small quantity of a good binding gravel, prepared by the addition of clay, if necessary which would be laid after the main mass of gravel or earth had been placed and its surface rammed to a few inches below

the road surface. If a binding gravel is not available ordinary gravel or road metal may be rammed into the surface of the main filling. The work of filling bomb holes must, of course, be co-ordinated with that of dealing with broken sewers or water pipes one point being that very deep craters should immediately be filled nearly up to the levels of such conduits.[1]

Transport units can withstand a raid if they are small. Instances of machine-gunning and bombing of buses have come to light, but yet they are preferable to trams, light railways and bigger units within city limits and on the borders. A system of transport by buses should be encouraged and railway termini removed outside the city zone.

All glass must be removed from omnibus windows or they must be protected by netting or other anti-scatter device. Anti-blast adhesive netting has been fixed in the windows of a number of buses, trolly buses and trams in London. Blast and splinter-proof bus stands for passengers are also necessary within vulnerable zones. We should, however, remember that garages for buses and public transport should be erected outside crowded cities where they could be housed in safety.

The problem of horse and bullock-drawn vehicles is pitiable. They should be encouraged to serve the reception areas and the outskirts of vulnerable cities. Otherwise protecting the animals will lead to difficulties.

Railway lines and stations give birth to serious problems. The huge stations could be easily damaged by indiscriminate bombing. Sandbagging, baffle walls, fire-fighting equipment, fire-proofing of material, removal of glass and window panes should all be done suitably to reduce the damage to the structure as well as to the people who frequent it. In times of crisis railway stations will be crowded and shelter protection should also be provided both for the staff and the passengers. In the interest of safety of passengers at two London Terminal stations glass has been replaced with roofing felt. Ruberoid roofing material was substituted for glass. At one station this involved the removal of 10,558 panes. At other stations glass has been protected by wire-netting. Arrangements for artificial lighting should be made in case the glass is substituted by opaque materials.

[1] *Vide* "Safety News", May 1940, p. 103.

Balloon barrage, anti-aircraft gun, and other devices are essential to minimise chances of damage and destruction. Effective camouflaging is necessary. For the stations are so huge and defy protection by the various measures discussed in the previous sections.

Railway trains are subjected to machine-gunning and bombing. One method of assuring safety is to camouflage the carriages. In addition the substitution of anti-splinter mediums to glass panes may be considered. Blast and splinter-proof tunnels at suitable intervals, might be built wherein the railway train can take refuge if raiders chase them. Such refugees may be equipped with anti-air craft devices. If suitable tunnels and hill sides are available they might be excavated to provide safe places for carriages and engines, when not in use.

Railway lines are liable to be destroyed by direct hits of bombs. Huge craters would prevent transport. Squads of workers trained to put lines in order and repair the damage quickly should be kept ready. Fire is another danger. A network of mobile fire brigades is in existence in Britain, each with its express engine ready to rush it to any fire. Fully equipped fire trains are also kept at key points for major outbreaks. Every goods and passenger trains on the railway system in Britain has its quota of sandbags. These measures are essential for any railway system.

If possible temporary platforms could be erected outside city limits and made the terminal so that even if the main station is bombed passenger and goods traffic might carry on unhampered. Suitable bus transports to the terminal to facilitate access should be organised.

Provision should also be made by Government to take over the running of essential services in case of need. The amendment to the Defence of India Rule empowering the Central and Local Governments to authorise any person to take over from a local authority or its officers, any of the essential services is a welcome move in this direction. The amendment has it :—

" If any local authority fails to comply or delays compliance with the appropriate Government's order or if it is necessary or expedient so to do for ensuring the due maintenance of the vital services of the local authority in the event of hostile attack, the appropriate Government may supersede the local authority.

Structures housing restaurants, clubs, cinemas etc., where large numbers congregate need every precaution, not merely to save the structures, but also to inspire confidence in the customers which is essential to run such institutions. In England 'cinema managers are finding camouflage an aid to business.' It has been discovered that where cinema roofs have been camouflaged and other steps taken to protect the public during raids, receipts have gone up and people have resumed the cinema habit.[1]

Finally protection to crops and stores of grain against enemy action should also be given careful consideration.

Regarding standing crops the advice of the Minister of Agriculture in Great Britain will be found very useful.

Alleys should be cut through extensive stretches of corn when the crop is green to limit the spread of a fire, and the immature corn will make excellent silage. Fire-fighting brooms made from local material and a good supply of water should be kept handy, together with any spraying appliances that may be available. Hay and corn ricks should be dispersed round the farm as much as possible. The Ministry's leaflet gives detailed suggestions. Apart from measures to be taken by farmers themselves, arrangements for light trailer pumps and stirrup hand pumps to be made available to fire authorities in the main corn-growing districts specially for use in fighting crop fires, have been made in Great Britain.

According to Mr. Joseph Edwards of the Cambridge School of Agriculture, two methods of control are possible. The first concerns treatment of the growing crop; strips of corn, about five yards wide, and running in the direction of the prevailing wind—namely north-east to south-west, should be cut through any large acreage. This should be done when the crop is eared and green and cut, either fed to stock or made into silage. The second point concerns the stocking of the cut crop. He suggests that the rows of stocks should run in the direction of the prevailing wind, and that two normal rows should be stocked as one so as to widen the distance between the rows. Both of these treatments should prevent any fire from spreading over the whole area.[2]

[1] The "Builder", Oct. 18, 1940, p. 375.

[2] *Vide* " Safety News ", September 1940, p. 139.

Decontamination of Building Materials[1]

The elements of nature are probably the best neutralisers we have—but often too slow for present-day life. We must, therefore, assist nature's action to reduce such damage to a minimum and lessen danger and inconvenience.

Concrete is a widely used material to-day and is found in all substantial buildings in varying quantities. Though durable and generally easily cleansed by normal processes, due to its porosity, it absorbs the persistent liquid gases readily. By the introduction of the various reputable water-proofing agents, it is possible to offset this characteristic to a marked degree, but not sufficiently to permit of no further treatment.

A simple treatment is ordinary silicate of soda or water-glass (one part water-glass to four of water), the first application being given when the concrete is green, and additional applications being given every four to six months. This treatment actually fills the small pores and voids at the surface, preventing penetration. The decontamination of such a surface can be carried out by swilling down with water and then sprinkling with bleach and brushing well. The bleach solution might be allowed to remain some thirty minutes before being washed off. Bleach should never be used alone, and if water is not available should be mixed with earth, ashes or saw-dust, in the proportion of one part bleach to from one to two parts of the other ingredients. It should be borne in mind that the brushing and action of the bleach will remove the protective covering of water-glass in time, and the frequency with which the water-glass treatment must be repeated depends largely upon the amount of use or wear the surface is given.

The contamination of a concrete surface by mustard gas vapour is not serious and usually the opening of all doors and windows for a few hours will be sufficient provided there is a strong current of air to blow through. Twenty-four hours should be enough in most cases, though heavy vapour contamination may require a longer exposure, especially if the air currents are light.

Should a concrete surface, which has not been treated to prevent penetration, become grossly contaminated for any length of time with liquid mustard gas, one application of bleach powder may be insufficient, and a further treatment of bleach cream and water

[1] *Vide* J. I. M. Cy. E., Vol. LXVI, No. 12, p. xiii.

should be allowed to remain over the affected portion for from five to ten hours, depending on how long the contamination has lasted before treatment commenced. Bleach used with water, or with earth, ashes or saw-dust, may be placed over the contaminated area as a neutralising cover. In many cases it might be wiser to remove the contaminated portion and relay the surface. This applies not only to concrete but also to prepared and plastered surfaces. Some authorities claim that decontamination of such surfaces can easily be achieved, but there is certainly no more trouble to hacking out and making good, and the certainty of protection thus afforded is infinitely greater and more desirable.

Great care must be taken regarding the disposal of the chippings or old plaster to prevent them from causing further harm. Burying in the ground is a safe procedure.

Sodium sulphide in a 1 per cent. aqueous solution or 1 lb. of bicarbonate of soda per gallon in commercial sodium hypochloride solution can be used if bleach is not available, but they are somewhat less effective. On the other hand, they are not nearly so corrosive to metals as bleach, and for this reason may be preferred. The value of these washes is increased if they are applied hot or boiling.

The treatment described above is suitable for cleansing glass or highly glazed tiles, but these materials as well as metal, may also be decontaminated by wiping off with petrol, paraffin, turpentine, alcohol, or benzine once or twice. Care must be taken to see that the cotton waste or rags used are carefully handled and later disposed of so that no one will subsequently be able to touch them and contract burns. Destruction by burning is probably the safest method for them if carried out in a furnace or other fire with a closed flue with a good draught. If placed in an open fire or bonfire, the fumes coming off might cause considerable injury to anyone not protected, for the gases so liberated would be of a strong concentration.

A blow-lamp applied directly to the place of contamination, which is marked or stained by liquid gas, is a treatment which could be used on bricks, porous tiles, and various building blocks. Concrete may also be treated in this way, but caution must be exercised in the extent to which the heat is applied or damage will be caused.

In some instances, excellent results have been obtained on road surfaces by spreading paraffin and then setting fire to it. Here, again, however, certain surfaces may be damaged if too harshly

treated and, generally speaking burning could only be resorted to in the country, where the bleach treatment cannot be applied.

Fibrous materials are the most difficult and in many cases are impossible to cleanse due to the facility of penetration by liquid gas. Hardwoods do not so readily absorb liquid gas as softwoods, but, nevertheless, certain penetration takes place. If treated immediately after contamination they may present little difficulty, but if contamination has been of long duration, the problem becomes a difficult one. The application of bleach, bleach cream, or bleach vaseline immediately after contamination will usually be effective, but three or four treatments with intervals between to allow the bleach to be absorbed may be necessary if the contamination is of longer duration. With softwoods, due to their porosity, treatments must be more thorough. When softwoods have been contaminated for any length of time, it may be almost impossible to neutralise the effect, and destruction by burning must be resorted to. The timber-yard presents many difficulties. Ordinary vapour contamination can be left to the weather and after a few days no traces of gas should be present. Liquid contamination, on the other hand, has to be treated with bleach. It is impossible to go into detail here, on how much timber is worth bleach-treating or how much should be burnt. In a state of war all timber becomes many times more valuable than in peace times. Long exposure to weather is a help but is not a cure, and affected timber must be used with discretion and only by a staff having some knowledge of decontamination.

Painted surfaces which have been splashed might be sprayed or brush-treated with one of the above solutions, or wiped off with paraffin or petrol. Here also, the plumber's blow-lamp may come in handy, for, instead of neutralising the affected area, its complete removal may be accomplished with scraping and the aid of the flame.

It must be remembered that throughout all cleansing operations those at work must, whenever possible, work on the windward side of the job and, in addition, be protected by proper clothing all the time, for in such operations strong concentrations of gas will naturally be given off which may have dangerous effects.

From the foregoing, it will be realised that fire-resisting materials are most suitable for building, to combat gases. Heat is the quickest neutralising process we have, and fire can be applied

in moderation to such materials. This refers particularly to liquid contamination and not to vapours, for ordinary wind and rain is sufficient in the latter case.

Thus all A.R.P. structures and particularly hospitals, first-aid posts, depots for working parties, report centres, telephone exchanges, and wardens' posts, should be constructed of such materials as concrete and brick-treated to prevent penetration, glazed tiles, metals, enamelled ware, and glass.

Organisations

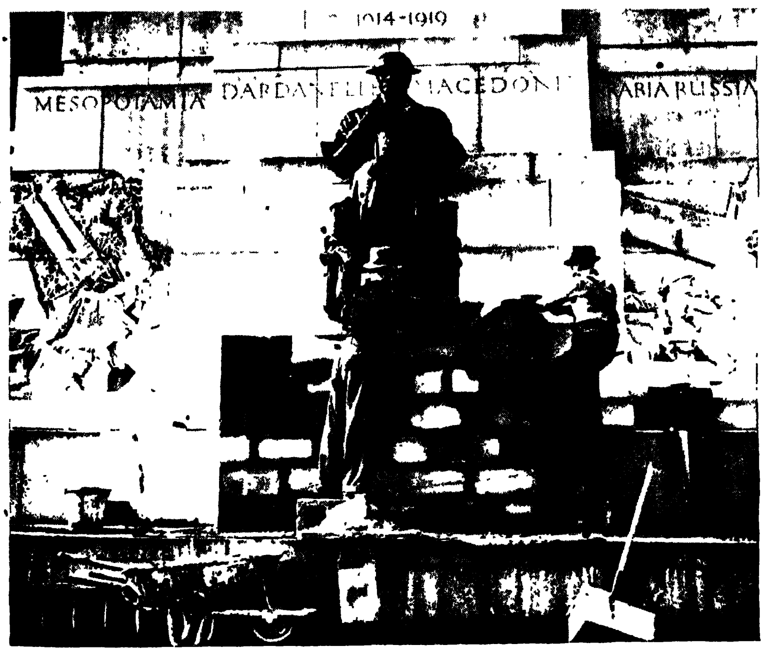
All these precautions will do much to reduce damage and destruction but they cannot prevent damage nor can they protect everything in crowded cities. Certain amount of damage and dislocation is inevitable and organisations of different kinds should be set up to deal with the consequences of destruction, to repair and rectify the damage and render life in the area possible. Fire-fighting services, rescue parties, demolition squads, decontamination parties, etc. are all needed; especially repair service for damaged buildings have a very valuable part to play. Thousands of skilled workers have been pressed into service in London for repairing bomb-damaged structures, for demolishing dangerous buildings and to clear debris.

Competent advice is necessary on all aspects of precautions. Expert guidance is indispensable even for apparently simple measures like sandbagging.

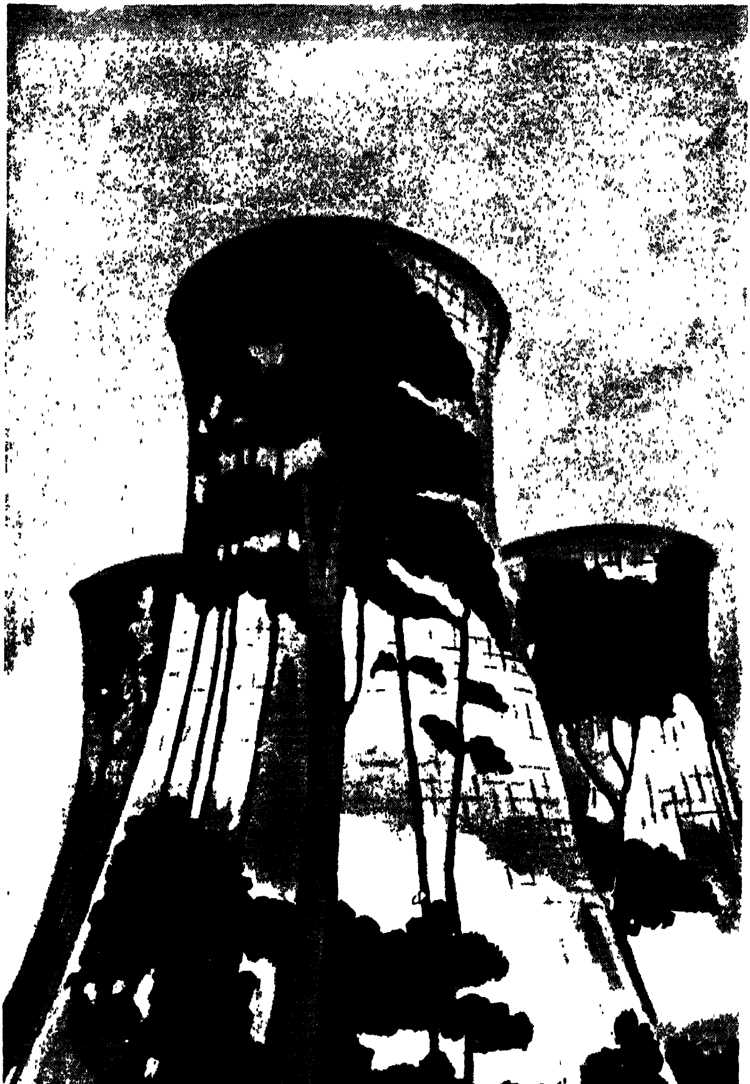
Even in Great Britain such advice is freely made available by the State to owners of factories and producers of essential services in vulnerable zones, who are compelled by the Civil Defence Act to camouflage their premises. In countries where A.R.P. is new this is even more necessary both to facilitate the public to adopt precautionary measures as well as to ensure that they are sound. It is the duty of the State to make expert advice freely accessible to the citizens in a poor country, and this measure would amply repay.

As far as possible it is better to avoid damage to structures needed for production and essential services. It is better even for other structures since this would reduce the burden upon A.R.P. Organisations. Camouflage and light obscuration thus assume great value in times of war. For the main principles, we turn to the next chapter.

A sandbagged hospital in London



Hollow concrete blocks are used instead of sandbags to protect this statue in London



The late Oliver Bernard's[1] scheme of Camouflaging Cooling Towers, by painting. Recent Camouflage practice however recommends bold disruption only.

[1] Was the principal assistant to Solomon J. Solomon, Chief Camoufleur with the B. E. F. in France in the last Great War

CHAPTER X

CAMOUFLAGE AND LIGHT OBSCURATION

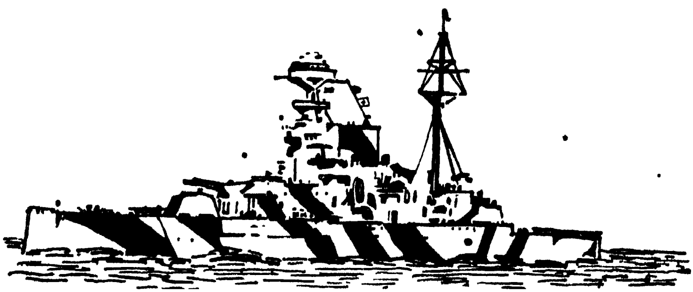
CHAPTER X

CAMOUFLAGE AND LIGHT OBSCURATION

Introduction

Camouflage in Civil Defence includes all those measures which are designed to make a target less readily recognisable to the airmen. In other words, it is the technique which helps to obliterate conspicuousness of objectives on the ground, to the airmen. Used in its widest sense, camouflage includes any kind of deception practised by military, naval, air force and civil authorities to conceal their objectives from the enemy's view.

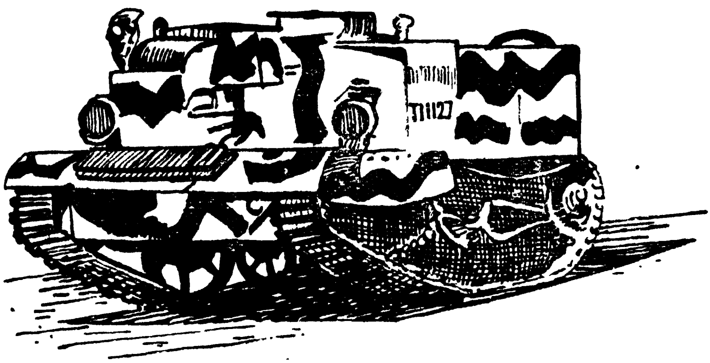
Some sort of deception has been practised by the field forces ever since battles began. The Trojan Horse is a classic example. Dummy canons have been used in warfare during the middle ages. The Boers, Napoleon and Stonewall Jackson adopted various tactics to conceal military manœuvres. The submarine warfare aggravated the need for camouflage of the navy. Ships were dazzle-painted to



A dazzle-painted battle-ship

escape the submarine. Towards the end of the Great War, it was even made compulsory for every merchant-vessel to be camouflaged, and some 4,000 ships were dazzle-painted in 1918. Railway carriages transporting ammunition, were similarly treated in France. Troop movements and army practices were carried out by the Germans under opaque overhead covers concealing the movement below.

Recently allied troops were hidden in Tobruk so very successfully, by camouflage measures, that they were not seen until they sprang to the attack from the " apparently deserted and shelterless no man's land," which led the angry Nazis to coin the sneer, "Rats of Tobruk." Hiding an army in the field is a most difficult job of camouflage at any time, but in the bare waste of Tobruk it is seemingly impossible. However, with every man co-operating, vehicles, artillery, field works and camps disappeared into the brown dust and rocks of the desert. The Italians built Tobruk and afterwards its defences, but even they did not seem to know their own town. Such was the excellent method of concealment and deception worked out by an Australian unit.[1]



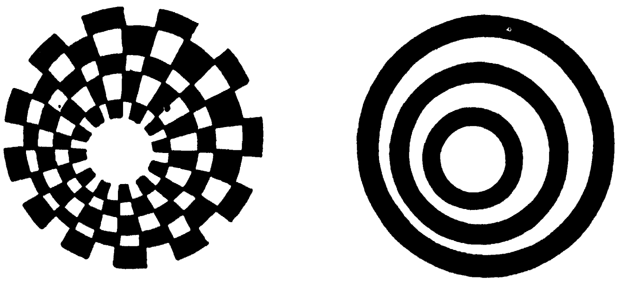
A camouflaged Bren Gun carrier used in East Africa by Indian troops in 1941[2]

Camouflage measures are broadly classified into four groups, namely, military, naval, aerial and civil. Military and army activities such as the Germans carried out under cover, might be classed in the first group. Germans covered miles of roads and acres of fields with rigid hangers coloured and modelled to represent the original scenery and they also successfully concealed great military activity in orchards and fields covered with open squares of cellulose fibre material or wire. Rigid roofs helped to grow vegetation and the Germans kept them very low and sloped all the edges down at an angle not exceeding 15 degrees to the horizontal to avoid shadows.[3]

Objects to be concealed are covered with string or wire-netting and the process is sometimes called strategical camouflage. N ava

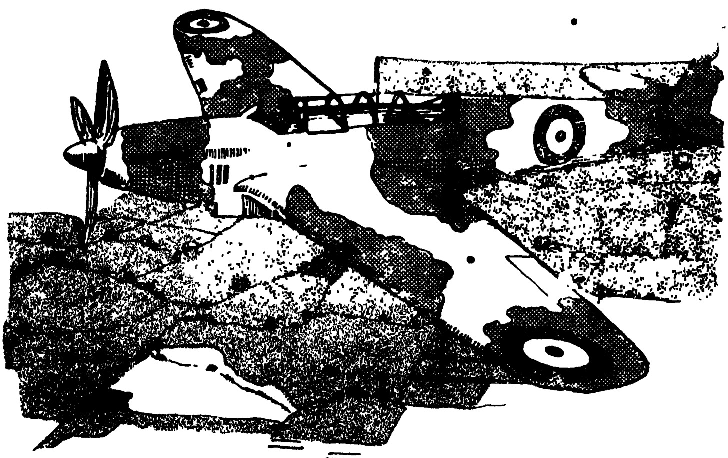
[1] *Vide* the "Hindu", 28-12-41.
[2] Hutchinson's Pictorial History of the War, No. 6, Series 11.
[3] *Vide* C. W. Glover: Civil Defence, p. 558.

camouflage includes smoke-screens and dazzle-painting of ships in inverted perspective. The purpose of the dazzling lines is not to make the ship less visible to the enemy, but to deceive him as to its size, direction and speed. Effects are produced, which when viewed at a distance of even half a mile, would suggest that the vessel is travelling in a deflected path to its actual course. In some cases, it would even become difficult to know in which direction the ship is proceeding.



A type of dazzle-painting recommended for moving objectives

Aerial camouflage includes the camouflaging of air-craft. Disruptive patterns are painted over the air-craft while the under-



A camouflaged air-craft

side is given a light hue and the two cleverly merged to produce the effect similar to the countershading colour effect of fish in water.

When viewed from above, the disruptive patterns would make their detection difficult, while air-craft in the air would be almost impossible to locate from below on account of the colour of the under-side which would merge them in the sky.

Civil camouflage, which has come to the forefront in recent times, includes all those measures which help to disguise the shape and the shadow of objectives on the ground. Railway stations, power-houses, nerve centres, factories, oil tanks, means of communication and transport, and other objectives whose destruction would break down the resistance of the people, are entitled to camouflage treatment. In the belligerent countries, these objectives are camouflaged and great ingenuity is exhibited by the Germans. They have even planted full-grown trees on top of tall buildings, painted green bicycle paths and broad drives through parks, and stretched nets like those used by trapeze performers over lakes, ponds and other bodies of water to prevent them from reflecting the moonlight.[1] The nets have been painted to look like anything but water. In some ponds they have created floating islands of grass. Railway stations in Germany have been ingeniously made to look like hillocks. Oil tanks in vulnerable areas receive most careful disruptive treatment.

With the advent of total war, camouflage assumes a special significance as an essential protective measure for civilian objectives. Centres of vital war production as well as those essential for maintaining the urban community are treated in a manner which make their detection extremely difficult. Its importance and value are so great that camouflage measures are compulsory for vital centres in Great Britain. The Civil Defence Act of 1939 empowers the Government to enforce it wherever it is considered desirable. According to that Act :—

Section 45.—*Camouflage*

The Minister may serve on the occupier of any factory premises a notice requiring him to take or complete such measures as may be specified to secure that the premises are less readily recognisable by air-craft.

Section 46.—*Grants under Part VI*

There may be paid out of moneys provided by Parliament towards the approved expenses of any persons on whom a notice

[1] The "Sunday Standard", 3-8-41.

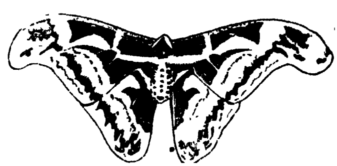
has been served under the two last preceding sections in taking the measures specified in the notice grants not exceeding one-half of those expenses.

Section 47.—*Penalty for Failure to Comply with Notice*

If any persons fail to comply they shall be liable to a fine not exceeding one hundred pounds, and if the failure continues they shall be liable to a fine not exceeding fifty pounds for each day on which the offence continues. A reasonable period from the date of the conviction may be fixed for the compliance with the requirements of the notice and where the Court has fixed such a period the said daily penalty shall not be recoverable for any day before the expiration..

A new Defence of India Rule published from Simla on 23-8-1941 "enables the Government to take or to require people to take such measures in respect of any premises as may be necessary to make the premises less readily recognisable in the event of an enemy attack." The object is to carry out camouflage where necessary. The importance of this in certain circumstances needs no emphasis.[1]

Nature exhibits some of the most effective forms of visual deception and provides us valuable guidance regarding camouflage measures. The butterfly, the chameleon, the rabbit, the partridge, the zebra, the panther, the elephant and the giraffe, possess colours and patterns as aids to disguise and concealment, and the reptiles—the snakes—carry patterns which render detection of their presence nearly impossible. The fish too have protective colouration to help them in the struggle for survival.

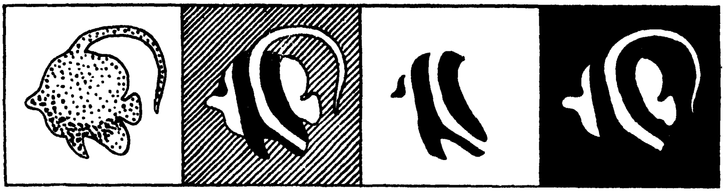


Disruptive patterns found over a kind of butterfly

Volumes have been written by scientists regarding the colour scheme adopted by nature to protect the various living organisms from their enemies. All animals are coloured in such a way as to best secure their safety and other interests and not so as to expose them to danger. For instance, the dark colour of the fish on the upper dorsal side and the pale white hue on its underside explain

[1] "Hindu", 23-8-1941

this phenomena. When looked from above, the colour of the back coincides with the deep black sheet of water and when observed from



Disruption in Nature : Patterns over a fish showing their effectiveness

below, the pale hue is in tone with the colour of the thin layer of water made transparent by the light rays above.

Patches of contrasted colours are sometimes distributed irregularly over an animal's body to catch the eye of the observer and distract his attention from the form of the animal, such as we find on the zebra and the panther. The elephant in a shady jungle is an outstanding example of adaptive colouration. It is possible to come very close to the animal without recognising its presence. The protective colouration of the chameleon is well known. Researches in the range habits of brown pocket mice in New Mexico, have revealed that the brown mouse turns white in the white sands of the New Mexican desert, black in the lava beds of the nearby Malpais, and red in the red sands near Alamogordo. It has further been discovered that even lizards in these areas turn partly white, black or red after a short stay.

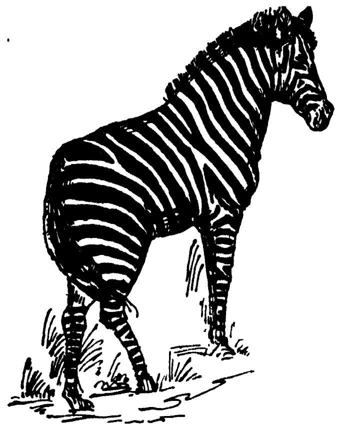
The devices adopted by Nature to protect her creatures might be grouped into six classes.

1. Adaptive colouration ; such as is found in green snakes, etc. The creature has a colour and tone which blends it into the background.

2. Disruptive pattern ; as those found upon the panther, snake, etc. which attract attention to the disruptive pattern and render recognition of the shape of the object very difficult.

3. Behaviour and imitation ; as found in stick insects, grasshoppers, leaf butterfly. Behaviour and imitation make the creatures look like some natural feature such as twigs, leaves, etc.

4. Dazzle-painting ; such as is found in the zebra. Bright contrasting colours and tones are cleverly used to dazzle the eye of the attacker and make it difficult to judge the direction of movement of the animal.



The Zebra

5. Countershading ; such as we find in fish. Light tones underneath and dark tones on the top reduce the appearance of solidity.

6. Deception and disguise; as is found in the butterfly. Classic examples are the false eye on the wings of the butterfly and the false eye of the fish, near its tail. It reduces the chances of attack on the real eyes. Some insects even disguise themselves as something very different ; the fly, for instance, which looks like a moth and the moth which looks like a worker-bee ; the latter manages to enter the hive to steal honey.

A frog and how it disappears into the background

Nature offers security to her creatures by keeping them in harmony with their environment by various other helpful measures. Man however by ignoring nature and environment has failed to provide safety to his handiwork. Man made objects by the regularity of their outline, by their geometrical shape and shadow, by their difference in colour and material stand out con-

spicuously in the landscape when viewed from above. The ground when viewed from the air shows a vast area with patterns characteristic of its vegetation, cultivation and human habitations. This pattern varies according to the activity of the people who live in the area. Paddy fields show dark grey, and irregular patches of white and red indicate an Indian village; while a more regular lay-out tells an English village. Woods and forests appear almost dark owing to their rough surface or texture, while a sandy desert shows a very light hue. Footpaths and country roads appear a little darker than concrete roads.

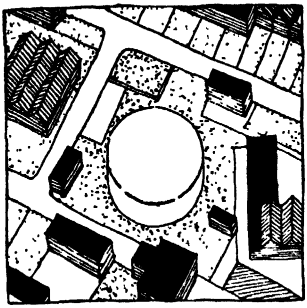
It is the reflected light which shows the object to the air observer. Texture of the surface therefore determines the degree of visibility and objects are seen in varying shades according to their surface, whether smooth or broken. The plain level ground reflects most of the light and appears light in colour to the airmen as well as in normal photographs. Walls and roofs reflect most of the light and hence appear prominent in the landscape.

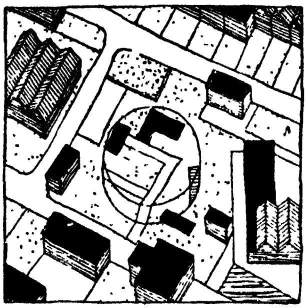
Three features help to make buildings conspicuous; their colour, shape and shadow. Building materials generally do not conform to the earth colour. The burnt brick, the fired roof tiles, the cement mortar, the colour finishes, the whitewashing and the corrugated iron roofs are thus discernible. A geometrical and regular shape appears conspicuous by its contrast to trees, vegetation and contours of the surrounding area.

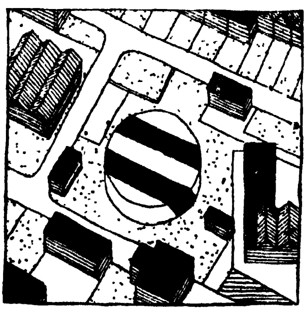
The most conspicuous feature is the shadow. No natural object throws a regular shadow, and since the shadow may be very much larger than the object, most part of the day, attention of airmen is invited to its presence, and its shape makes the recognition of the object comparatively easy. A factory, for instance, with its expansive roof and its ploughed field aspect, due to shadows in the valleys of roofs and its regular shadows are easily detected. An aerodrome with its large units regularly laid, its concrete runways and administrative blocks is readily recognised. Railway stations by their size and characteristic shape are also easily spotted.

To conceal a building and make detection difficult, it is necessary to deal with the colour, the shape and the shadow. Protective colouration as found in animals is adopted for build-

ings. By suitable paints and designs, an object could be merged in the neighbourhood. The ground pattern should be painted over the roof, and the walls toned down to suit the landscape. Otherwise the outline of the building could be disrupted by painting patterns resembling the neighbourhood. Structural excrescences might also be added to distort the shape. For instance a large oil tank shows itself up by its round shape which is most difficult to obliterate. Suitable schemes are painted over, and the shape also distorted. Paint cannot eliminate shadow It is concealed and distorted, by garnished netting, and shaped excrescenes. Whenever, these prove inadequate dummies are made and cleverly located to mislead the airman by drawing his attention and bombs to it to prevent the risk of attack to the original objective.


A large gas holder in an industrial area.


Imitative patterns painted over to merge it in the surroundings[1]

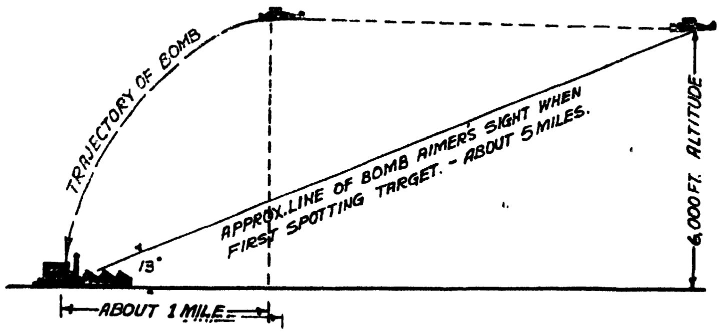

Bold patterns drawn over with a view to disrupt the outline[1]

Camouflage measures need not completely cover a building and hide it from the view of the onlooker. This is obviously impossible for most structures and unnecessary. It is enough if the measures render recognition from a distance difficult.

Although location of targets is known from air photographs, and camouflage of large installations against modern photography is practically impossible, the bomber pilot finally depends on his own vision when releasing the bomb. It is necessary to recognise the

[1]These methods alone have now been shown to be quite ineffective and toning down is first adopted in modern practice and camouflage treatment is applied afterwards.

objective at a distance of several miles if bombing should be accurate. If the target is not recognisable at a distance, the bomber will miss the target. After he drops his bombs, if he starts to search the local defence will get an opportunity to deal with him. Camouflage thus achieves its purpose.



Locating targets from air-craft and releasing bombs over them

Let us suppose the airman is flying at 10,000 feet ; the bomb will take 25 seconds to reach the ground. The speed of a modern bomber is usually 200 to 240 miles per hour. Taking the higher speed, the plane travels one mile in 15 seconds and would be nearly 2 miles off the target when the bomber releases the bomb. The operations all take time. So the bomber must be able to spot the target at a distance of 4 miles from it. The vast expanse of view from an aeroplane gives a vast area of the country to be searched, in order to find the target. A bomber looking for a factory, not knowing whether the plane is pointing dead at the factory or not, travelling 240 miles an hour, may find himself on the target before realising it. All we need do in camouflage is therefore to make the buildings look as innocent as possible, that is to say, as much like the surrounding country as possible. Accurate bombing requires an uninterrupted view of the target and even the clouds which interrupt such a view is a serious handicap. A bomb aimer can afford to miss the target for only five seconds. But a series of five-second interruptions would render it difficult to hit anything deliberately. The ideal of camouflage therefore lies in presenting the raider with a landscape devoid of arresting features.

Shape : Merging and Disruption

Camouflage measures should therefore aim at obliteration of colour, distortion of the regularity of outline and concealment and

disguise of shadows. Colour and shape (to some extent) are dealt with by suitably painting the different surfaces of the objective. Application of suitable colour and design could tone down the object into the landscape.

Imitation of the surroundings, be they rural or urban, should carefully reproduce the ground pattern effectively on the building, its roof and walls. It is unnecessary to produce details and make an exact copy of the surroundings. It is enough to present a picture whose broad essentials are in harmony with the ground pattern, to escape notice. To normal vision under good condition, an object must be more than 6 feet in its least dimension to be visible at 5 miles and considerably larger to be noticeable. The size of camouflage pattern should conform to this rule and small buildings and details could therefore be conveniently omitted. The imitative patterns should eliminate regularity.

Camouflage of large areas, such as factory roofs etc. cannot be achieved by this method. The area is too vast and the outline of the building would attract attention.

Disruption or distortion of the form of the building is therefore necessary to make it unrecognisable or inconspicuous. This depends upon producing patterns which have some bearing to the prevailing ground pattern but which do not conform to the edges, and by the clever use of netting. The object when camouflaged must completely merge with the ground pattern of the surrounding areas, in colour, tone and texture.

Disruptive pattern painted over should cross the contours and break the edges of the building. A pattern which is wholly contained by the outline of the object and follows its contours will have little disruptive effect. Disruptive pattern should be continued on the building and down the side and on the ground itself. Adjacent patterns should differ in tone, and the disruptive pattern must appear natural. Otherwise, it would be

Typical disruptive patterns

conspicuous. For example, a chalk quarry pattern however well reproduced, will fail to achieve the object if the ground pattern has none of them. A light coloured red, painted across the roof of a building, will only look like a road, from two aspects, that is, in direct prolongation and will look unnatural, seen from other aspects, for it will appear broken by each successive roof ridge.

Disruption can be very successfully attempted on buildings which have trees near them. By continuing either the shape of the trees or their shadow irregularly over the walls and roof, any strong contrasting tone, the form of the building will be broken. Regularity in the shape and size of disruption should be avoided. Patterns must be large and bold to be effective, preferably it should never be less than 20 feet in any direction. Disruption applied to a roof must be carried down over the walls and merged into the ground. Scene painting on the walls should never be attempted. The pattern adopted should conform to the surrounding landscape and should never attract interest.

The four main principles underlying disruption by painting are :—

1. Reproduction of the ground pattern by duplicating natural tones and patterns.

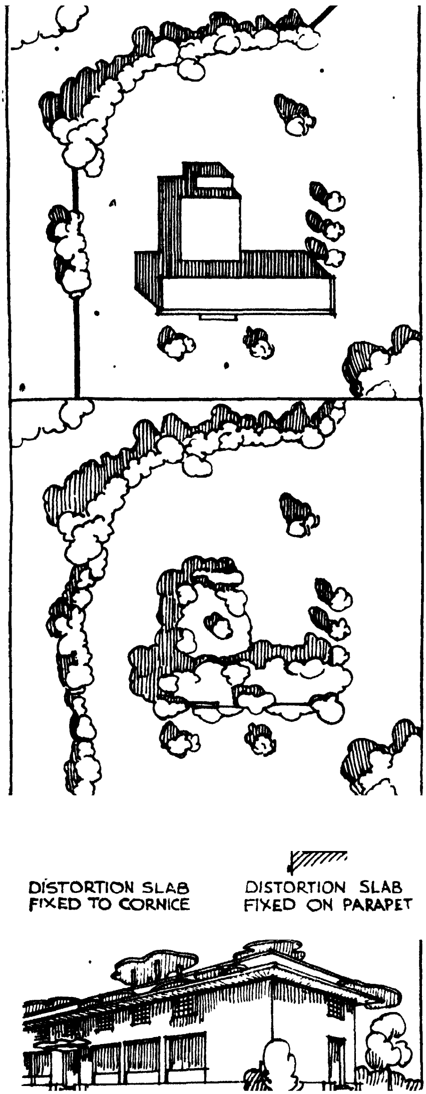
2. Colours must harmonise with those of the landscape in tone as well as in contrast.[1]

3. Details and small patterns are unnecessary and a bold sweeping treatment is required.

4. The disruptive patterns must be continued down the sides and ends of buildings and over the adjacent ground.

A very expensive but more effective disruption of the outline of an object can be achieved by means of flat, irregular shapes suitably fixed to structures. All additions to be of real value must be capable of resisting wind pressure, cyclone, effect of heat and cold and heavy monsoon. A large flat platform cut to the shape of a tree can be attached to the eaves of a building so that it projects into the shadow area. This form of disruption is very effective since natural shadows are created which move with the sun. But its disadvantage is that they have to be of a large area not less than 20 feet in the least dimension and are consequently very difficult and expensive to fix.

[1] Exact colour match is immaterial, for colour fades.



Structural distortion of a building : *top*—aerial view : *middle*—aerial view after distortion : *bottom*—perspective view showing the distortion slabs in position.

The designs or patterns to be drawn over objectives must harmonise with the essential features of the surrounding landscape, to be effective. A careful study of the ground pattern thus becomes essential.

The ground pattern is the airman's view of the ground below him. It is the earth's surface in plan. There are seven broad varieties.

1. City and urban
2. Farmland.
3. Paddy fields.
4. Forest.
5. Desert.
6. Mountain.
7. Combination of any of the above.

They vary from the natural 'wild' ground pattern extremely rough (mountains) to extremely smooth (deserts). While the urban pattern is more regular, the rural is more natural. Cultivated land and towns all over the world conform to a similar pattern, patch work quilt and crossword puzzle regularity. Indian villages reveal a muddled appearance—no well defined pattern but fields of various colours with hedges and patches of wooded country.

Trees, meadows, fields, as well as separate leaves, show us a wealth of greens in infinite variety. In a leaf all the processes of reflection, absorption and scattering take place in the same way as in an ocean hundreds of feet deep. Absorption is caused here by the chlorophyll grains, scattering is probably brought about by innumerable grains of all kinds in which the contents of the cells are so rich, or perhaps by the unevenness of the leaf's surface.

The upper sides and the under sides of leaves differ in tint even if the illumination is the same. The upper side is smooth, therefore reflects better and so is also more patchy. The under side is duller and paler and shows more pores.

Trees seen against the light stand out darkly against the distant background and make us feel its distance, its remoteness, more sharply. A distant wood in a flat country can actually be compared to rows of hills. Meadows give one level expanse of a single colour and an impression of smoothness and open space, and seen at a distance, its green runs to blue green and further off, it approaches more and more the atmospheric blue of the sky.

Shadows are to be found between the trunks and stems in woods and shrubberies, and in open windows in towns, viewed from a distance. They are spaces in which we can only look through a narrow aperture. The light rays which enter it can emerge only after being reflected a number of times, becoming considerably feebler each time. Dark woods absorb nearly all the rays and re-emit only four per cent. of the incident light. The darkness of a wood is, however, only relative, and if we draw near, the eye having once become adapted to the light, we can see that everything in it shows light and colour. Similarly every detail in a room, seen from inside can be distinguished, whereas the same room seen from outside through the open window looks pitch dark. Delicate objects outlined against the bright sky usually look black.

Where the sun shines, its brilliant yellowish rays predominate over the light radiated from the sky ; but in the shade, light only falls from the blue or grey sky. Shadows are, therefore, generally bluer than their surroundings and this difference becomes accentuated by contrast. In flat or gently undulating country shadows accentuate the relief only when the sun is very low. Its rays then almost graze the surface of the ground, causing very curious variations of light and shade.

There is a remarkable difference in colour and structure to be seen in almost any landscape, depending on whether we look at it towards the sun or away from it. The entire aspect of the scenery changes. A field of young corn, a meadow, a field of lupine, are yellow-green towards the sun, but away from it they are bluish. The waves in a field of ripe rye are chiefly caused by the changing aspect of the ears; facing the sun, we see practically only bright light waves; looking away from the sun, we see a few bright but more dark waves. A lawn mown with a lawn mower looks much lighter in colour when the direction of mowing is away from us than when it is towards us; in the former direction we see much more reflected light. Freshly ploughed land glistens if one looks at right angles to the direction of the still damp furrows. Duckweed on the water of a ditch behaves in exactly the opposite way to grass. Away from the sun it is yellow-green, but towards the sun pale grey green. Fruit trees in full blossom are white only when seen away from the sun; seen towards the sun, the blossoms stand out black against the sky. The branches and twigs of trees are grey, and brown seen away from the sun, black, without detail, towards the sun.

A brick-paved road is brown-red towards the sun, white-grey away from the sun. A gravel road is white grey towards the sun, brown-grey away from the sun. An uneven road, covered with snow, seen towards the sun, looks as a whole darker than the smooth snow at the side; away from the sun it is the other way round.

Photographic tone ranges from black to white. The tone depends more upon the light reflected towards the camera than upon the colour of the object. If the light is reflected directly into the camera, the surface will appear light. The relative tones of the different parts of an objective change with the point of view from which they are observed. For different surfaces act differently on the incident light and this is noticeable when flying round an object.

Most surfaces in nature are rough, since they are covered by trees, grass, shrubs, etc. Each is composed of a number of small surfaces which reflect light in different directions. The more light they reflect upwards the whiter they will appear. A grass field consists of a large number of minute points, each reflecting very little light and will hence appear dark; but if a man walks over it

and crushes down the grass with his feet, the crushed grass will reflect more light and will appear light.

It is essential to possess first hand knowledge of the light and colour of the landscape in which the objective to be camouflaged is situated, to arrive at the proper scheme that should be adopted.

It is equally essential that the colour chosen has the correct tone and texture.

The fact that it is the reflection of light which makes the object conspicuous, lends the tone greater importance, in camouflage schemes. Any coloured surface possesses three qualities, colour, tone and texture. Colour bears its usual meaning like red, green, etc. The tone depends upon the amount of light reflected by the coloured surface and is expressed in such terms as light red, deep red, light green, dark green, etc. The tone is largely determined by the texture which is the quality of the surface of the painted area such as matt or glossy. The amount of light reflected to the eye depends upon the quality of the surface or the paint. A matt surface scatters in all directions, light which falls on it. A glossy surface behaves according to the laws of specular reflection just as a mirror. At low angles of vision, a highly reflecting paint or glossy surface will reflect so much of sun's rays that it wi l be impossible to discover the colour that has been applied.

What really matters is therefore the tone and the texture. Colour tends to disappear in sunlight. It tends to turn to grey or disappear when seen from a distance due to atmospheric haze. It is the tone which is therefore vital for producing contrast. But the tone will not be appreciated if the surface reflects much light. Reflection completely destroys the effect of colour and tone. A glossy or smooth surface is therefore unsuitable. If the shine in the light of the sun should be avoided, the paint used should produce texture which would help to diffuse light in all directions more or less evenly. The amount of diffusion depends upon the texture of the surface. The more broken the surface and bigger the lumps, the greater will be the shadow content. Texture is therefore of greater importance than colour. A few tones sufficiently matt would produce effective contrast. But colours of the same tone would blend and neutralise each other. Three to five contrasting

tones may be essential, and would suffice since subtle gradations will be lost to view from the air.

Very few actual colours are therefore required, the number depending upon the local landscape. Select fewest possible colours after a careful study of the predominant colours in the locality to which camouflage treatment has to be applied. Browns, greys, buffs and greens are colours found in nature and are a sound basis for camouflage colours. The distant view should be considered in selecting the colour, for the green of a tree looked at from 50 feet will turn to a dark grey green when seen from the air. Unless the colour harmonises with the surroundings, the object would be conspicuous. A dark green colour scheme is unsuitable in the middle of a desert ; similarly a light buff treatment for roofs in a woody area. Large samples should be applied on the actual surface to be treated and examined, for colour in a small sample card or panel looks much lighter than when applied on a large surface on the exterior. Allowance should be made for fading and for the overlay of dust after application.

It is advisable to make colours darker than what is actually required. They must be fast and resisting the effect of sunshine. Colours fade when exposed to the sun and the brighter they are, the quicker they fade. This fading will affect the tone and the relation which one tone bears to another in the colour scheme adopted, thus upsetting our calculations and the efficacy of the patterns. Further, the colour applied to the slope of a roof towards the sun should be slightly darker than the side away from the sun to obtain uniform tone.

A chief difficulty in choosing a paint is that a sufficiently matt paint may not be durable. Fundamentally, a paint consists of a pigment, a medium to bind the pigment to the surface and a thinner to enable the paint to be spread. Mattness is produced by increasing the proportion of pigment and consequently reducing the proportion of binder. The result is reduction of durability and elasticity. Paints are classified into (1) oil paints, (2) oil-bound water paints, (3) bituminous paints, (4) silicate paints, and (5) cement paints.

Number (1) Oil paint is glossy when new and increased pigmentation to obtain mattness will affect durability. Number (2) Oil-bound water paints are matt, cheap and have good covering

capacity, but are less durable than white paints. They are suitable for many camouflage purposes. Number (3) Bituminous paints are dull in colour but cover most of the range required in camouflage. Number (4) Silicate paints are best suited for porous surfaces and stand weather. Number (5) Cement paints are as silicate paints but colour may fade.

Materials to be covered by camouflage paints are generally corrugated iron; steel, asbestos cement, slates, stucco, concrete, brick, concrete areas and roads, asphalt and glass. Oil and bituminous paints are the most durable for corrugated iron and steel and asbestos cement roofs; a priming coat to resist alkalinity is essential before using oil-bound paint. Oil-bound water paints may also be used. Bituminous paint can be used without the priming coat. For slates, stucco, concrete or brick walls, all the above paints are suitable, but an alkali-resisting primer may be required if an oil paint is used on concrete. Only a bituminous paint should be used on asphalt. There is no known method of colouring existing concrete roads permanently, as the wear and tear due to traffic may necessitate frequent renewal. In such circumstances, the most suitable paint is the one which is cheap, easy to apply and proof against adverse weather, occurring shortly after application. Bituminous emulsions fulfil these conditions, although all the other types of paints can be used.

For glass surfaces, these paints will obstruct light. Where light cannot be totally prevented, the glass pane should be covered with clear varnish and then spread lightly with granite or similar dust of size which will pass 20 mesh to prevent the shine from the glass used for north-lights or sky lights. When carefully done, shine can be effectively eliminated without cutting off more than 50 per cent. of light. Coloured particles could be used if roof patterns should be carried over them.

To produce a very good matt surface, a paint in which gritty particle have been incorporated during manufacture should be selected. The surface it produces will have an excellent texture and will be truly matt. They are not however durable. Coloured particles sprayed on to a coat of varnish or coloured emulsion also produce an excellent texture, but durability depends on the quality of the varnish used. Wherever possible, local grit such as breeze or brick dust can be scattered over a surface previously treated with

a binder such as bitumen. Size of the particles should not exceed ½ inch and require a coat of paint over them in order to secure good adhesion.

Ordinary flat paints are not sufficiently matt to overcome reflection at low angles of vision. It is necessary to add something to roughen the surface. To conform to the landscape prevailing in India, bajri well ground or earth, can be mixed, taking care that the binding medium will prevent their flaking off when dry. Milk is considered effective to prevent flaking and could be.used as a thinner while earth is mixed.

Camouflage paints both oil-bound and washable, as well as water paints are manufactured and supplied in different shades. Flat, oil, gritty or non-gritty, and extra oil-bound distemper type, gritty or non-gritty, for all types of surfaces are offered by manufacturers as suitable for spray or brush application. If made from guaranteed light-fast pigments and absolutely non-reflecting, the finish may remain unaffected by wet weather. Anti-reflection finishes for glass roofs or windows, are also offered in the market.

The selection of colours—colours to be of lasting quality, unequal for hiding power, washable, non-tarnishable, heat and weather resisting—paints selected must flow well, look well, cover well, and wear well and they must be quick and easy to apply, of rapid drying and reasonable effectiveness and durability.

Precautions to be taken in choosing colours are that there will be no variation in colour supplied. They should have good storage properties and the place of storage should be well ventilated and dry. There will be no fear of chipping and troublesome discolouration, crumbling and flaking. The material must be efficient and reliable. If so selected they would cut the time and trouble of mixing—a distinct economic advantage, especially on large areas. The material must have capacity for recotability and washability. There should be elasticity and grip in paints. Materials like G. I. Sheets and Asbestos roofs and walls must be provided with prime coat suitable to their respective qualities.

Specially designed equipment is available for applying colour to surfaces for camouflage purposes including gritty, non-reflective paints, A. R. P. window black and anti-splinter medium as well as for the preservative treatment of sandbags.

For greatest coverage in shortest time, a portable displacement sprayer is advisable. Aerograph Spray Painting Equipment provides a quick and efficient means for applying colour to surfaces. The B. E. N. Patents Ltd. have in their possession a machine extremely portable, entirely self-contained, with petrol engine-driven compressor, a large paint container and long reach spray guns. The 'Aerospray' is another variety of portable spray painting plant as also the Volspray Equipment which has special guns for spraying the sanded paints and dry camouflage sand recommended for use.

Excellent flat paints, very suitable for application to all types of glass surfaces, simple to apply and quick to dry, are sold in Great Britain. White road marking paints are also on the market.

Complementary lacquors used for windows and electric bulbs would let natural lighting during the day, but will not allow artificial light to penetrate out at night. They are made in two colours, blue and orange-yellow or amber. Windows are to be painted with blue lacquor and electric bulbs with orange-yellow lacquor. Blue translucent paint for windows and amber translucent paint for electric light bulbs are also applied. Since glass panes are either removed or protected for fear of blast these treatments have largely been given up in the United Kingdom.

Shadow: Elimination and Disguise

Even though the colour and shape of an object are effectively disguised its presence would be revealed by its shadow. For the shape of a shadow has a definite relation to the shape of the object which is casting it, and even though it goes through various distortions, it enables the observer who has studied shadow to recognise the form of the building which is casting it. Without a shadow such as on a cloudy day, it is difficult to judge the height of a building from a vertical view-point. The area of shadow increases and decreases in size and moves in the opposite direction to the sun's travel. Early morning and late afternoon shadows are the longest. No amount of paint will remove a shadow.

The vertical wall on the shadow side is in shade. Shade is generally lighter than the shadow due to the diffused reflected light reaching it from beyond the shadow edge. The tone of the surface on which the shadow falls determines the density of the shadows.

The lighter the surface, the lighter the tone of the shadow. But however light the tone or colour of the area, the shadow will be very much darker than the darkest object kept in direct sunlight. Therefore, a shadow thrown on a white surface will be darker than a black object in direct sunlight. The colour of the shadow assumes the same colour as the surface on which it falls, except that the tone is darker. To establish the area of a shadow, we must peg it out on the ground at 8 a.m. and 5 p.m. and run a line, white or chalk line from peg to peg to obtain the range of travel.

Shadows could be treated by netting and screening, by garnished netting, by trees and bushes and by counter-shading. From the edge of the building roof to the edge of the shadow, wires could be fixed. Over this supporting wire, a cover could be spread consisting of local and cheap materials such as hessian, canvas, woven bamboo or grass mats, chicks, chittai, leafy branches of trees, etc. Garnished netting may be used. Chick or wire-netting or expanded metal could be fastened to the supporting wires and interwoven with narrow strips of gunny or leaves. If time permits, quick-growing creepers could be grown and allowed to climb the netting. It is advisable to carry pegs beyond the shadow area, as this presents a lower angle and gives less difference in tone between the flat roof and the sloping roof.

Trees and bushes break the shadows when suitably planted and thus help to disguise the form of the building. Countershading of the shady side of an object may sometimes prove very effective. The colours (tones) used must carefully intermingle at the point of junction. Painting the shadow surfaces with light colour will reduce density to a great extent but is suitable only in congested areas for deep closely reflected shadows such as we find in narrow streets. In open surroundings, this would make the building conspicuous on a cloudy day, while it may be helpful during bright sunshine.

There are four ways of dealing with shadows cast by an object.

1. Elimination of shadow, is done by attaching canvas sides sloping gradually to the ground at an angle of 15 to 30 degrees to the horizontal. This prevents the shadow from being cast. The canvas could be painted to harmonise with the surrounding landscape. The slopes are brightened to a lighter tone as they are of a darker shade. Canvas should cover the eaves and cornices,

and this method is very effective. The Germans adopted this measure in the last war to conceal military manœuvres.

2. Disguise of shadow, is done with the help of string or wire-netting. It acts like the curtain in a window. The vision is obscured since the light outside the netting is greater during the day, than within. When the netting is coloured lighter than the shade within, the shadow cannot be detected. String netting made of hemp or cotton should be suitably dyed and rot-proofed. Field forces garnish the netting with hessian or steel wool or aluminium plates if available to create solids and voids which help to add texture and make the netting process absolutely effective. Without garnishing, the shade of the netting will show and a hundred per cent. visual deception may not be possible.

The net is considered a most suitable material for concealing large areas of glass used in factories, since daylight is not obstructed. The mesh recommended is half inch[1] or less when measured in the diamond either way. Where a non-reflective surface has to be covered, the mesh could be larger.

3. Shadow distortion is achieved by dummy trees, artificial excrescences and by netting. Flat boarding not less than six feet in its least dimension in plan, and painted suitably are fixed to the eaves and cornices of buildings, raised above the roof to throw shadows on the flat roof itself and also along the straight edges of the shadow of the building. Garnished netting could also be similarly used. Where a regular shadow edge is cast, dummy and real trees could be planted. Occasionally, wire-netting sloping down from the roof may also be used.

Shadows could be killed by transforming them into intermediate ' blobs ' appertaining to the local ground pattern. Dummy bushes, trees, rocks, etc. are made in conformity with the ground pattern and sited to break up the shadows.

4. Counter-shading. The shadow is always darker than the shade. By countershading, the shady portion of the roof and walls could be made indistinguishable from the shadow and be made to appear continuous with the shadow itself. Countershading can make a surface in relief look flat. The portion covered by the

[1] *Vide* C. W. Glover: "Civil Defence", p. 565.

shadow can also be painted lighter to harmonise in tone with the walls in shade. The roof towards the sun and also the walls, could be darkened to match the side opposite. This method is considered very effective in congested areas where one object throws its shadow on the other. This, however, is inadequate, for viewed from a different angle the objects become more conspicuous by the colours. The change in the direction of light from the sun, renders countershading, a very defective method.

A combination of methods to disguise and distort the shadow has to be adopted for success and for these measures, string or wire-netting serves as valuable material. Of all camouflage materials, net is perhaps the most effective and is chosen by the field forces for its portability.

The theory underlying the net is based on the common experience that it is difficult to see into a room fitted with a light lace curtain, the lace absorbing all our attention and producing a screenic effect. The veil-like curtain is strongly illuminated and if the objects in the room have only a small percentage of that brightness they add to the uniform brightness of the veil a fraction too small to be perceived. At night, when there is a light in the room, you can see through the curtain quite well. The side nearest to us is practically unilluminated, and only imposes a very feeble illumination on the objects of various brightness in the room. For those who are in the room and look outside, the effect is in both cases the other way round. The same phenomenon occurs when an aeroplane, clearly visible in the moonlight, is no longer to be found when a searchlight is used. The air b tween our eye and the aeroplane is illuminated by a beam of dazzling light which prevents us from seeing the weak light-contrasts behind it.

String or wire-netting serves a similar purpose as that of the lace curtain. Garnishing by creating solids and voids, and shadows which harmonise with the surrounding ground pattern makes screening by nets more effective.

The object of garnishing is to obtain the correct proportion of solids and voids which produce texture as is found in the landscape, to enhance the efficacy of netting. Garnishing is in essence, thickening some part of the area of the net so that texture is produced and the reflected light rays are diverted and prevented from reaching the eye of the observer, thereby misleading the air

observer. Any local material could be used if it is suitable for garnishing. Brushwood, grass, crops, straw, coir, sea-weed, leaves, jute sliver, chicken feathers, raw wool, goat hair and horse hair, are classified as natural garnish, while manufactured garnish includes cloth, hessian patches, hessian strips, shrimp nets, plywood, asbestos sheets, scrim, vignetting, chittai, steel wool, steel shavings, aluminium plates, etc. Experience has shown that any material, natural or manufactured, with which the desired effect can be produced could be used. There is no rigid rule about the choice of material for garnishing. We must produce the correct colour, tone and texture by the most convenient and quickest method possible. Selection of garnish should, however, be made with care. A ground and air reconnaissance, a study of the colour, tone and texture, of the site and its surroundings, the type of frame that should support the garnished cover, and the necessity for fire-proof materials or otherwise, should be given consideration. While natural garnish requires constant renewal, artificial ones need colouring by paints, dyes or stains, which are not good natural colours and are liable to fade.

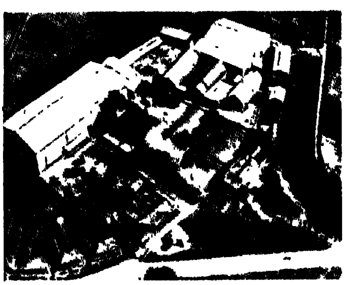
Garnishing must produce a texture and tone that would harmonise with the surroundings and the pattern adopted should imitate natural shapes. The net used is often square and the following precautions are suggested to obtain ideal results. The garnish should disrupt the shape of the net by breaking the square outline. The shadow thrown by the pattern should harmonise with the ground pattern and should be irregular, and the ends should not run parallel to the edge of the net. Garnish must be thicker in the centre and thinner as it approaches the edges, and the colour must merge in the landscape. Its colour should be a little darker in tone than the surroundings, since colour is liable to fade. Scrim, if used, should be twisted to produce texture. If other materials are used, solids and voids should be thoughtfully spaced. Wherever possible, natural vegetation should be used to supplement artificial garnish. Looked through half closed eyes or through field glasses thrown out of focus, the efficacy of garnishing could be tested.

Sometimes, it may become necessary to conceal the objective completely. Garnished netting serves the purpose most effectively and field forces resort to overhead covers to conceal their gun and other positions. Such covers should be garnished on the top to harmonise with the ground pattern. They are erected in the same

Garnished netting used for concealing a machine gun post

A 25-lb. gun and its crew camouflaged by an overhead cover of garnished netting

A gun emplacement covered by camouflage netting



A large factory in a rural surrounding

The same factory camouflaged by paints, nets, etc

fashion as ordinary roofs. Large overhead covers are generally erected to conceal operations connected with the construction of dams, assembling bridges or land mines and sometimes over sections of roads, to hide traffic. To prevent oblique view, side screens or curtains are attached around the open ends. When a suitable site is selected, erection of a camouflaged overhead cover is simplified. Trees, bushes and open ground produce patterns which could be effectively imitated by garnish. Trees along roadside help to suspend the net between them, obviating the task of erecting posts to carry the netting.

Garnish, over the horizontal surface of an overhead cover, should be thickest in the centre, and towards the south. Garnish should be vignetted towards the edges in an irregular shape, to help distorting the shape and shadow below. The garnished area should completely cover the area occupied by the shadow cast by the object. Wood or metal frames could be used. Air reconnaissance at 1,000 to 5,000 feet is essential to check the effectiveness of such covers.

The method of erecting large overhead covers has been standardised by the field forces in view of the importance and frequent need for such a cover. The procedure follows the method adopted for erecting large tents. For cloth-garnished netting, string or wire, the spacing recommended for intermediate posts is 15 feet maximum, whereas 8 to 10 feet is permitted if light-grass and bamboo-covers are used. The diameter of the posts should vary from 2 to 4 inches. With 12 or 14 gauge wire, one length preferably, a skeleton frame is made. Intermediate and diagonal wires are then fixed and the cover, previously garnished and disrupted, is put over the frame. Side screens at a slope of 25 degrees to the horizontal are attached where necessary, and these are fixed a little above the head of the horizontal plane of the roof to prevent shadows. Where side screens meet, sharpness is to be avoided.

To large civilian objectives overhead covers would prove very expensive, but vital units, of factories and power-houses, where power plants are installed, could be concealed by overhead covers. The ridges between the roofs of large factories and the ploughed field appearance conspicuous by the shadows in the valleys, could also be treated with garnished netting. Where total concealment by one overhead cover is impracticable by size

or other reasons, side curtains as recommended for large overhead covers could be attached to objectives to conceal shape and shadow.

Dummies

If the existence and location of an objective are well known to the enemy it is necessary to mislead the airman by some means to a wrong place to deal his blows and waste his bombs.

The ideal way is to camouflage the objective effectively and at the same time to set up a dummy at a safe distance to the original, but close enough to decoy the bomber pilot and bombs, *i.e.*, from half a mile to quarter of a mile.

Dummies are classified into two groups: those that scare the enemy and force him to divert his course by their apparent strength, and those that help to invite the enemy's attention and waste his blows upon them. A dummy mine-field or anti-aircraft battery may divert the enemy, while a dummy oil tank will invite his attention and waste his ammunition. Most things connected with war can be reproduced as dummies, from the smallest machine-gun to the biggest battleship, such as the Scharnhorst. Dummy aerodromes, buildings, tanks, lorries, guns, pill-boxes, dumps, gun-emplacements, camps, obstacles, etc. are made. Sometimes dummies are used to trick the enemy, such as an artificial tree, a dummy road, and dummy damage to structures.

To be effective, the dummy must have every essential feature of the original, with the minimum of detail. Dummies must pass off as the real thing when carefully observed from the distance, from where the enemy would have the chance to look at them. The materials used must be strong and light, preferably portable and convincing, easily assembled and dismantled. Siting must be carefully done, and the correct background and setting should be chosen. They must be maintained with great care, and any large scheme must be complete in every respect. Dummies must be camouflaged cleverly, enough flaws being left to invite the observer's attention. They should, wherever possible, be large enough to throw natural shadows, dummy shadow being avoided as far as possible.

'Dummies must be thought out in terms of a general scheme and their maximum effect depends upon carefully worked-out

association of ideas.' Since they depend upon the element of surprise for their success, absolute secrecy should be maintained about them. They should, however, be constructed before the real positions are erected in the case of field units, or at the same time. They must emerge clearly out of the ground pattern by their characteristic features, which are the same as those we have to camouflage in the real objective. It is, therefore, necessary that the main characteristics must be accentuated. Dummies should preferably be planned and constructed in secret and assembled on the site.

For producing effective dummies a careful study of the characteristic featuros of the original is necessary and the following hints would prove valuable. The characteristic features of railways are long straight tracks with gentle curves, embankments, cuttings, dark area between lines, light paths alongside signals, tunnels, stations, etc. The dummy should, therefore, have light embankments or cuttings, large stone aggregates, covered with engine oil, telegraph posts, signals and fences. Ballies or other suitable material should be laid as rails. If necessary dummy bridges, trees, as also goods wagons made of wood framing and gunny cloth, could be used. Occasional working parties along tracks, are recommended by authorities. A dummy road is obtained when the surface effect is produced by sprayed tar, cement wash, tar, gravel, etc. Stone aggregate for metal, dummy trees and tracks would add to its effectiveness. Tracks are easily made and are very helpful. They should not be terminated abruptly, but extended to a suitable termination..

Concrete surface appears light in photograph, macadam surface dark grey and gravel or mud track, dark. Concrete and macadam roads are usually highways, possess few sharp corners and reflect light. The sharp curves of gravel and mud tracks are indistinct when viewed from the air. The surface effect obtained for the dummy should produce these colours, tone and texture effects, if it should be effective.

Dummy trees could be made with ballies and artificial branches covered with two-inch mesh wire-netting lightly garnished with coir or steel-wool. They should be sited in clumps. They help to break shadows, to conceal small units and to distort shape. Characteristic features of trees viewed from the air are, their dark texture, tell-

tale shadows and "roundness of form". Real trees could also be transplanted by suitable arrangement, and sometimes very large trees are also replanted this way. The use of trees without life with newly cut branches of green leaves is, however, deprecated, since the leaves will fall off sooner or later and the dry twigs will show differently.

Light net or wire frame covered with gunny cloth, suitably sized and painted, and coated with creosote to stand the weather, produce dummy rocks, and these are very helpful in treating large camouflage schemes containing several building units located on hills.

There are two ways of producing dummy buildings. They should accentuate the characteristic features of the originals, in the locality, their tone, their roofs and their tell-tale shadows.

The first way is to remove patches of turf of the shape, the size being much larger than the three-dimensional original, of one side of the sloping roof of a building. This will represent the sunny side. The other side of the patch should be left normal and the turf suitably darkened to represent the shadow. The second method is to construct three-dimensional dummy buildings of mud, ballies and other cheap locally available materials of nearly full height. These are advisable in open areas.

The details of doors and windows should be avoided. The effect of height can be intensified by the clever use of bush, trees, battering of walls and by the judicious use of contrasting tone colours.

In congested areas, dummy shadows and plinth are effective. Shadows must be thrown on each other and the correct tone should be obtained.

A dump has the characteristics of a large depot and possesses buildings surrounded by mounds, tracks, railways, roads, etc. In erecting dummy dumps, we must get dummy houses, mounds made of garnished netting, tracks, railways and roads.

There is no satisfactory method of producing water effect by dummies. The best solution is to use real water, although bright galvanised iron, tin, silver and plain glass are suggested for imitation. These, however, cannot produce satisfactorily the bright

glint, the changing tone and the peculiar impression of depth which are the characteristic features of water while viewed from above.

Circular frames and galvanised iron could make dummy oil storage tanks. An earth cover is added and the height intensified by using bushes and contrasting tone colours to produce the features of the original, namely circular shape, characteristic shadow and earth bund.

A large dummy bridge is not a practical proposition unless it is erected and used as an alternative crossing. In that case, it becomes a major engineering problem. A medium sized dummy bridge can, however, be made. Very light dummy bridges are made with wire strands hung with gunny cloth. To be effective, these dummy bridges should possess clear approach by road or rail. The shadow of a bridge would differ in tone between the bridge and water, the parapets are of a lighter tone, while the track is darker. It is necessary to remember that traffic must be closed to the public if these dummy bridges are to be erected.

Methods : Materials : Measures

Air observation of an objective is the fundamental requisite for successfully camouflaging it. Both for devising a scheme for adoption and for testing its effectiveness after application, aerial reconnaissance of the objective is essential. Although the technique to be adopted depends upon the objective and local conditions, the following procedure is advisable.

1. Examination of aerial photographs of the region and the objective, study of site and lay-out plans, ground photographs, etc. which are available.

2. Reconnaissance flight over the site and the surrounding country.

3. Ground reconnaissance of the site and buildings, examination of vital plants, replaceable and rest non-replaceable, and their location,[1] ground photographs of key buildings.

4. Ground reconnaissance of the surrounding area.

[1] The cost and value of the entire objective including its contents should also be ascertained to determine the proportion, which expenditure on camouflage bears to the cost of the objective.

5. Preparation of lay-out plans; sections and elevations of buildings. Zoning of the objects and the zoning of the respective units of the objective in the order of importance.

6. Analysis of data.

7. Air photographs and views.

8. Preparation of complete camouflage report including lay-out plans, etc.

9. Preparation of model, if necessary.

10. Application of the scheme to the model.

11. Execution of camouflage scheme to the objective.

12. Record all activities and efforts connected with the scheme.

13. Air reconnaissance during and after execution for verification.

14. Treat the scheme as a whole and not in bits.

The different stages of work are; ground and air reconnaissance; zoning of objects and landmarks and listing each unit of the objective in their order of importance; preparation of preliminary report, including an approximate estimate of the cost of the entire objective and the value of its contents; a general description of the contents is also necessary. A model should then be made and the camouflage scheme should be applied to it. Work should be done on a unit of the whole scheme to enable a more accurate and detailed estimate. Preliminary and even final estimates cannot be very accurate in camouflage schemes and a reasonable and good percentage for contingency must be allowed, since camouflage schemes may sometimes have to be altered in the course of application. The final report should then be prepared and approved before the scheme is carried out. Ground and air photographs should form part of the preliminary and final reports. Air photographs preferably in colour would be of great value.

Successful camouflage should be attempted at 5,000 feet. Frequent air observations of the camouflaged objective should be made to note the effectiveness of the measures under the changing conditions in tropical climates. Camouflage to be successful needs considerable attention not merely during the application of measures, but also upon their maintenance, after application.

A camoufleur, before he attempts any scheme, should first do ground and air reconnaissance and survey the objects and their landmarks, including the surrounding areas in further detail to enable him to zone landmarks and objects which need serious consideration for camouflaging purposes. He should decide then which area could be regional and which one could be individual only. In both cases landmarks are of great importance. Where a camoufleur thinks that toning down of non-vital buildings is desired because of their conspicuousness due to their colour which may give clue to the enemy, they should be toned down to merge with the surrounding colour so as to make them less conspicuous.

A model helps to determine the effectiveness of a scheme at a very low cost and is of great value when many similar objectives need treatment. It should, however, constitute an exact replica of the original, so that shadows can be easily plotted out and mathematical calculations of areas etc. worked out accurately. Models are recommended for small pumping stations, small and large factories, depots, arsenals, etc. pill-boxes, gun-emplacements, coast defences, aerodromes, water cooling towers, hangars, etc. Any material suitable can be used for the construction of models. A scale of 1/200 is recommended, but it should depend upon the time available, proficiency of craftsmen, heights from which models may be viewed and the cost. $\frac{1}{8}$-inch to one foot scale is also suitable for models. Accuracy in scale models is of the greatest importance and ground pattern must be included in the model. An observation tower may be erected if a suitable place to view the model from above is not available, the height depending on the scale of the model constructed. Installations are generally camouflaged to deceive the high level bomber. Successful camouflage should, therefore, be adopted at 5,000 feet. To construct a model, the following are essential.

1. Low altitude photos—500 to 1,000 feet.
2. Air photos at 3,000 feet and above.
3. Personal reconnaissance of the objective.
4. Lay-out plans, plans, elevations and cross-sections.
5. Contour plans or maps.

Photo checks should be carried out at every stage in the construction. Check tone with camera and get the right colour effect to deceive the camera. Good camouflage should also deceive the observer's eye. A definite programme is required to effect quick operations. Stated in order of importance, they are

1. determining the scale and the preparation of working plans,
2. the making of the platform,
3. gridding—marking out,
4. the cement base, and
5. the ground pattern.

The camouflage pattern should be experimented on the model and checked by photographs and by observation from appropriate height. A view in the open from a roof or observation tower so as to get the appropriate relative height and distance is desirable, but in its absence, it could be checked in a " sun laboratory " which is a dark room containing a turn-table and an artificial " sun "—a powerful lamp which could be swung into any desired position.

Since objects appear different when they are viewed " up sun " or " down sun ", aerial photographs from the four sides are necessary as well as reconnaissance, when the shadows are longest—morning and evening. The cooling tower disruption so successfully executed by the late Oliver Bernard was the result of using scale models, first attempted by him.

Since aerial reconnaissance and interpretation of aerial views and shadows form the essentials of successful camouflage, one who has experiences of flying and air photography is considered essential to make a successful camoufleur. Basically, of course, everybody who has pretensions to experience in art, architecture and natural history can be considered a potential camoufleur, as Myerscough Walker observes. A pure artist may know a great deal about colour and the representation of realism but he knows nothing of natural history nor ability to visualise a building unless presented with a scale model. Neither can he prepare drawings that can be handed to others for structural alterations. The architect knows building and is conversant with the fundamentals of colour as applied to structures but is deficient in ideas of natural camouflage. The naturalist knows the theory of camouflage from natural history

but is unable to draw technically or visualise an unbuilt structure. A combination of all these faculties and proper training are necessary. A knowledge of building construction and materials is absolutely essential for the static camoufleur.[1]

Various kinds of materials are required in camouflage, to,

1. change the appearance of the surface of the objective, *e.g.*, paints, etc.

2. conceal a feature or surface, *e.g.*, netting.

3. give texture to concealing and screening materials, *e.g.*, coir, bushes, etc.

4. distort the shape, by excrescences such as asbestos cement sheets.

5. distort aerial view by such things as trees, plants, shrubs, creeper, etc.

Various materials required for camouflage purposes have been standardised for use in Military works. Since in many cases specifications alone cannot ensure that the articles are satisfactory, standards should be produced so that the correct type of materials could be obtained. Materials to be used in any camouflage scheme should be decided on the type, place, and under varying atmospheric conditions. Effectiveness of any scheme of camouflage depends upon the materials used. At the present time there are no special camouflage materials in India which have been developed for the purpose, except special camouflage paints, nets and scrim. India possesses a great many indigenous materials which are suitable for development for camouflage purposes. Scientific Research Boards and Laboratories regionally placed must be established and worked under competent skilled research workers. This would help towards improvement of existing products and formulation of new materials to keep pace with the varying demands and requirements. They must be subjected to careful tests for immediate and subsequent vigorous conditions of the tropical sweltering sunshine, cool and hot and rainy weather.

[1] The case of an architect has been strongly made out by Lt.-Col. Chesney based upon his experience as a camoufleur with the B.E.F in France during the last war. Since camouflage extends far beyond the sphere of paints and leads to structural alterations, an architect is considered suitable for effective schemes of concealment, both by his training and outlook.

India has to realise the necessity for camouflage. Germany erects and demolishes strategic landmarks overnight and Russia hides whole armies. Camouflage is a battle of wits and not a dull building job. It calls for the most careful exercising of the brains. The art of camouflage is not a machine-made product. A camoufleur must have imagination and train of thought, undisturbed power to visualise, and ability to conceive the whole scheme in its proper perspective. All these if travelled properly in the right direction and in their proper angles of perspective are almost bound to success. Each object to be camouflaged will have to be dealt with independently on its own merit with due regard to its ground pattern which may probably vary in each case. A factory considered vital in Singapore or a power station concealed which caters for million lives in a city, are worth all labour and pains. It is a vital job which India needs badly.

A combination of concealment, distortion and deception according to the locality and the vulnerability of the objective should be adopted to produce the most effective camouflage. The ground pattern, vegetation, climate, possible direction of the approach of the enemy air-craft, nature of ground defences and the strength of interceptor planes, should all be taken into consideration in evolving the scheme. Experience during the past two years, however, provides valuable clues in respect of most of the objectives commonly chosen for air attack. Arranged in the order of importance they are, defence posts, pill-boxes, gun-emplacements, etc., aerodromes, producing centres of war materials, oil storages, ware-houses of essential commodities, means of communication and transport, nerve centres such as power-houses, water reservoirs etc. and civilian structures.

DEFENCE POSITIONS.—Defence positions cover both static and field defences. The static defences include light machine-guns, pill-boxes, dock-houses, gun houses, anti-tank and road vehicle obstacles, light anti-aircraft guns, entanglements, land-mines, observation posts and large coastal batteries. Owing to the vital importance of siting to obtain best results from camouflage measures, a ground and air reconnaissance is recommended before the site is selected. Precautions during erection are also necessary to prevent the enemy from pin-pointing their location. A general precautionary measure recommended is the use of dummies, screens and tracks, clear of occupied area. Hiding the tracks used is also suggested.

During construction, wherever possible, regularity of outline must be broken to conform with natural features. Smooth surfaces should be textured. Auxiliary buildings must be carefully sited and disrupted, and the texture of concrete facings should generally be made rough. Associated structures should be constructed and disguised by disruptive painting etc. to look like local buildings. They should be treated like camps and barracks. Everything should be toned down to harmonise with the landscape.

Anti-aircraft guns should be sunk into the ground and nets and brushwood used to conceal them. The tracks leading to them should be concealed so as not to reveal the position. Search-light positions should be made to look like huts. Pill-boxes would remain inconspicuous, if they are properly sited and disguised to look like surrounding objects, whether in urban, rural or coastal area. Its outline must be broken. Blockhouses and gun-houses have characteristic shape. Their lines must be broken wherever possible, and precautions must be taken against blast effect. The subsidiary fixings must be strong. Since siting is the most important consideration for the efficiency of defence posts, suitability to concealment is the next consideration.

Coast defence units comprise several items and exhibit certain regularity of lay-out. The various units which comprise the coastal battery are gun-emplacements usually in pairs, magazines, battery, observation posts, anti-aircraft guns, light machine-guns, search-lights, and associated quarters such as the engine house, A. R. P. shelters, tracks, turning loops of vehicles and considerable quantity of spoil caused during construction. They should be treated as part of one scheme worked out to defeat all forms of air attack. Siting has, therefore, to be given special attention. Overhead cover must be used throughout erection. The concrete used for gun-emplacements and aprons should have rough texture. Rough irregular corrugation should be made on the surface of the apron and its hard edge broken. Sea-weed and brush-wood should be secured by means of wire-netting. Treatment should be varied for twin emplacements. Light cover which could be quickly removed should be adopted for guns. The most disturbing feature in most static defence positions is the presence of tracks and spoil, and unless controlled throughout, they would present obstacles to effective camouflage.

AERODROMES.—Their vital importance leads the enemy to pin-point their position even before wars begin. If the enemy has pin-pointed the location of objectives and these are only toned down they would still continue to be well defined targets. Camouflage measures should, therefore, aim at increasing the difficulty of recognition, since their position or location is already well known. Visibility from distance should, therefore, be reduced, since aerodromes are generally near large urban centres and main highways. The features that help recognition of an aerodrome are generally :—

1. Large areas well defined by runways made of concrete with a highly reflecting surface.

2. Large hangars with hard stands for planes.

3. Air-craft on ground.

4. Tracks formed by air-craft and service vehicles.

5. Associated buildings—stores, bomb dumps, quarters for personnel, administrative buildings, aero clubs, ground defences, etc.

6. Proximity to large cities and main roads.

All these items should receive special attention in the camouflage scheme. Complete concealment is virtually impossible for landing grounds. Making it conform with the local ground pattern after careful reconnaissance and photography is the only feasible solution. Indifferent efforts generally fail. Initial cost and maintenance constitute the chief problem. Dusting powders, bituminous paint, waste oil mixtures, coal-dust, coke breeze, etc. are recommended for use. Anything which may be blown up by the propeller into the mechanism of the modern aero engine should be avoided.

Runways must be treated like the landing ground, and the scheme adopted should harmonise with the latter. Concrete and tarmac runways should be sprayed with hot bitumen and then dressed with pre-coloured stone chippings gauged to about one-fourth inch with a light roller, like those of old motor wheels.

The surface must be rolled, and a thin layer of tar with local dust dressing may produce a matt surface which will prove very effective. The treatment for runways is usually very expensive.

Similar treatment is required for large areas of tarmac or concrete on which planes are warmed up. The ground pattern should be carried over the area in combination with disruptive patterns on the hangars. If the local background justifies it, netting of shadows and disruptive colouration would prove helpful.

Associated buildings should be treated as part of the whole scheme. Dummies might be constructed and suitably located. If there are ground defences and bomb stores, the former should be treated like small static defences while the latter should be concealed by overhead garnished netting. Dummy planes, dummy bomb craters, etc. suitably located would help to mislead the airmen. Concealed dispersal points for air-craft in neighbouring fields are however essential, but tracks leading to them should be avoided.

Siting is a fundamental consideration in camouflage treatment, and the lay-out of the aerodrome should, wherever possible, tend to follow some general ground pattern. Advance landing grounds should be made to conform as nearly to the original pattern as possible after levelling. Gravel might be tried for runways. Where asbestos or concrete roofs exist reflection results; the hangars could be roofed with a view to camouflage.

FACTORIES.—Factories are generally very large and comprise different units such as stores, administration, power and the different manufacturing departments. Roads, railway sidings, gasometers, chimneys and cooling towers may also form part. A factory is easily detected by one or more of the following features.

1. Large homogeneous expanses of roof with their ploughed field aspect due to shadows in the valleys. Some factories have a roof area of over a square mile. In the case of north-light roofs this effect is particularly noticeable.

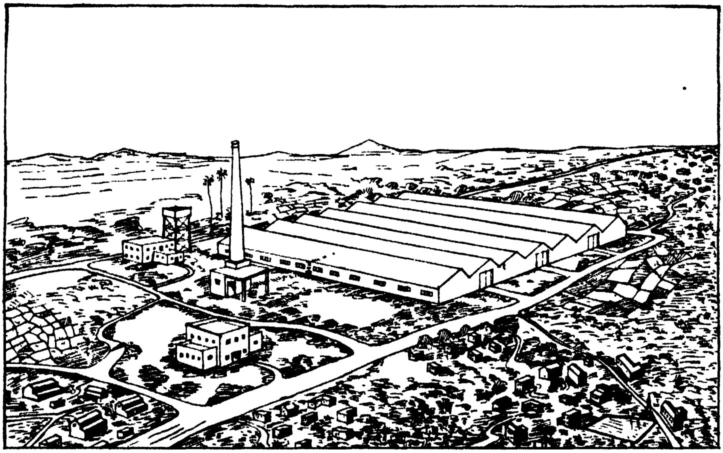
2. The shine from roofs caused by the reflection of light from smooth surfaces. When the observer looks towards the sun, this effect will be particularly conspicuous.

3. The bulk of the units such as large gasholders.

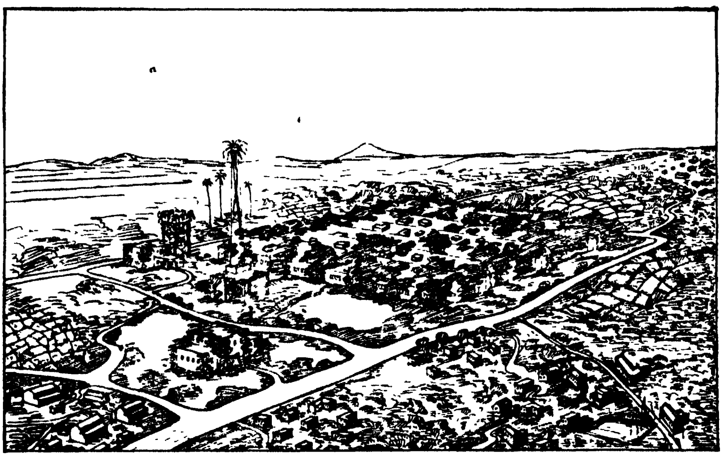
4. Regularity of shadow and silhouette, especially in the case of oil tanks or petrol depots, considered most difficult to obliterate and very difficult of complete solution.

Workshops show as busy areas usually containing a proportion of buildings larger than is normal in the neighbourhood, frequently

having specialised construction in roofs—spot lights, good roads, and often rail or water communication. There are also waste dumping grounds.



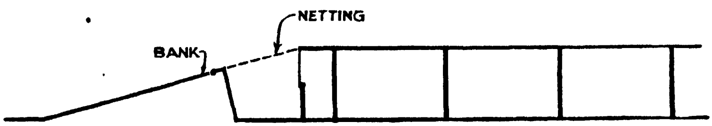
A typical factory in a rural surrounding



A view of the above factory camouflaged

Storage yards possess good road and rail facilities and well spaced out marshalling yards. Railway lines are usually the characteristic feature and they are not suitable subjects for camouflage.

The different units should be examined, the most vital ones singled out for total concealment, the others toned down and certain others should be left alone. Total concealment of all the units should not be attempted. Large lengths could be broken by painting the surrounding ground pattern over the roof and the side walls, either an agricultural landscape, a village or urban pattern. Netting to conceal the shadows in the ridges is helpful, while the shadow sides could be treated with garnished netting covering completely the shadows cast. Dummies could be used to mislead



Economical method of netting to conceal shadows cast by a building with flat roofs

the location of vital power units, while real and dummy trees could be planted to break the outline of the shadows wherever netting would prevent access to vehicles. The measures necessary for camouflaging a factory are : changing or breaking the form of the objective, by irregularly placed structural additions ; distorting or removing the shadows by garnished wire or string netting ; cutting long lengths of buildings by suitably connecting parts of ridges, by wooden planking or garnished netting or by colour or dummy trees and bushes. Cutting long lengths of buildings could also be done by colour. Bold disruption can be attempted, avoiding regularity both in shape and size of the disruptive pattern. Painting the glazing in the roof would prevent daylight entering the factory and garnished wire-netting is therefore suggested to conceal them. Patented devices to cover them during emergency are being used in Great Britain, where by automatic control, opaque board,—camouflage painted—covers the glazing whenever required. Large overhead covers made of garnished netting could be adopted for the vital plants that cannot be quickly replaced in times of war. Bulletin No. C. 13 recently issued by the Research and Experiments Department of the Ministry of Home Security emphasises the need for camouflaging glazing in factory roof lights or in windows. No treatment may be required in certain built-up areas, but for large factories in suburban or rural areas, expensive camouflage is often necessary. It may be painted

on the glass or the outer surfaces of external shutters, any anti-shine preparation applied to the outer surfaces of the glass or it may be nets. Nets suspended horizontally from ridge to ridge of a saw-tooth roof cut off some light from the vertical or steeply sloped north-lights. The standard net may cut off about 30 per cent. of the daylight through the window it shields. Nets from the eaves similarly cut off light which might otherwise enter the factory through vertical glazing in the walls. Anti-shine treatment for glass may reduce the amount of light transmitted, as much as 40 per cent. or more when the glass is clean and it will be much more when dirt begins to collect.

These three measures would reduce the natural light entering the factory. The glazing area should, therefore, be larger in future constructions. If the amount of natural daylight should not be affected by camouflage treatment, external shutters become necessary. They will carry camouflage patterns and will serve the purpose of obscuration. A fundamental requirement in their design is that they should be capable of being closed very quickly immediately a warning is received.

If the glazing can receive camouflage treatment letting in sufficient natural light, internal obscuration system could be employed and a considerable saving of expense could be effected.

The specifications and drawings made by the Research and Experiments Department are intended mainly for north-light factories. Movable shutters in panels hinged to flap or to slide or to fold so that they can be moved away from the glazing are recommended for external shutters. For internal shutters, sheet materials of weather-resisting character, which would resist glass splinters, are recommended. Internal light weight screens have to be suspended so that they do not fall to the floor when thrown out by blast. Any inexpensive flexible light weight sheet material that is not liable to warp might be used with a light frame and painted to make it weather-resisting. The following sheet materials are considered suitable.

1. Kraft liner board. .0126 inch minimum thickness.
2. Corrugated fibre board.
3. Solid fibre board.
4. Wall board or building board.

5. Ply wood in frame.
6. Wire-netting and fabric.
7. Box shooks.
8. Thin metal sheets.
9. Plaster board.
10. Fire-resisting sheet material.
11. Insulating boards.
12. Matting of the grass or fibre variety.

Since large factories with several units form almost a town concealment, disruption and deception, by painting and merging the units in the landscape, by disruptive patterns, by breaking large ones into small units, concealing and breaking the shadows, and by dummy structures, we have to produce an effective scheme. It is also essential to locate, if possible, vital plants in buildings as distant from each other as possible and to stock the manufactured products in different units and store them in distant places. Structural alterations also form part of the measures designed to ensure safety.

Siting, planning and construction are fundamental considerations. These three are essential to help successful concealment. "The problem of concealment involves care in the selection of sites, care in the choice of methods of construction, suitable treatment and the distribution of buildings on the site and in particular, attention to the lay-out and construction of roadways."[1] It has been strongly recommended in Great Britain that the civil defence camouflage establishment should be consulted at the earliest stage in war-time building project, where advice is given free.

The Research and Experiments Department of the Ministry of Home Security has recommended some designs for factories, helpful both for camouflage and for resistance to bombs.

The best type of roof for camouflage purposes is a flat one with no projections whatever. Increasing experience has emphasised the importance of this. A succession of arched spans is admissible, from the point of view of camouflage, provided the arches are

[1] Mr. R. Fitzmaurice, "War-time building." "The Builder", March 14, 1941, p. 280.

reasonably flat. A new factory type having a completely flat roof, is now added to the range of designs, and slight modifications to the glazing and eaves details have been made to reduce shadows.

At the request of the Directorate of Camouflage, Ministry of Home Security, another type has been put forward to meet the needs of camouflage and steel economy. It is further stressed that the three following requirements are just as important as the final camouflage treatment, and are fundamental to its full success.[1]

1. Careful selection of site to avoid proximity to readily located landmarks, etc.

2. Careful consideration of lay-out of buildings and of site arrangements generally to avoid undue regularity, and to merge the factory as much as possible in the surroundings.

3. Careful consideration of the design of building types to meet the camouflage requirements.

Already authorities in India have indicated their intention to control the design and construction and lay-out of buildings and structures, to reduce their vulnerability. Camouflage requirements could also be incorporated when details are worked out, so that the structures may obtain not only greater strength to resist air-craft bombs but also greater chances of escaping them.

In future planning orientation of buildings or objects is to be carefully considered to minimise the shadows.

OIL TANKS.—These are very conspicuous by their shape and shadow, by their proximity to harbours and by the railways, roads, and tracks that lead to them. Generally circular, they are extremely difficult to treat effectively, since the circular shape is the most difficult to deal with. No general scheme can be applied to these oil installations. Painting of the tanks with disruptive patterns, it is considered will offer "not more than 2 per cent. immunity value," owing to the circular form of the structure, which is the most objectionable form possible from the camouflage point of view. It is also stated that such treatment only serves to increase the evaporation losses in the tanks.[2]

[1] "Builder", 26-9-1941, p. 290.
[2] *Vide* C. H. R. Chesney: "The Art of Camouflage". p. 110.

Netting does not very much improve matters owing to the circular form. It is almost a maxim that circularity must be broken or covered over opaquely, if it is to remain unobserved. It is impossible to maintain efficiently netting and canvas unless expensive varieties are used, which would raise the cost to a figure equal to, if not greater than, that of deformation with really permanent materials. Surroundings might also render the use of netting unsuitable.

Each tank must receive its own specific treatment by deformation with permanent materials. Fire-proof materials alone should be used.

According to Col. Chesney, "80 per cent. immunity value" can be obtained by deformation. The net, according to him, does not offer more than 30 per cent. immunity value. Oil tanks and gasometers indeed are two instances in which the paint brush outlook is quite hopeless.

A. R. P. measures for the tanks and splinter-proofing to distant explosions require blast walls surrounding the tank. During construction, they could be suitably designed to help structural deformation by permanent materials, which would prevent circularity from becoming conspicuous. A little extra cost could obtain different forms for the several oil tanks that are found usually clustered near large urban centres. Fire-proof materials alone should be used for distortion, and netting of the shadow sides might prove helpful, if garnished with steel wool or other fire-proof garnishing matetial. Disruptive painting on the top is equally necessary. Where no blast wall has been built, steel posts could be used to help deformation. Considering the size, a large overhead cover of garnished wire-netting might be difficult both to fix and to maintain under changing weather conditions.

Means of Communication and Transport.—Communications may be roads, railways, both broad-guage and narrow, canals, rivers, etc., or telephone and telegraph requiring underground or above ground lines. All forms of communication are indications of activity, of headquarters, of extensive works. Defiles in communications are suitable objects for enemy attack—bridges, locks, ends of marshalling yards.

Listed in order of visibility are, concrete roads, tarmac road, water-bound macadam roads, and shingle and earth roads. A

concrete road is brilliantly white and regular and a modern production and invariably leads to an industry or place of military importance.

Railways, broad-gauge, have wide smooth curves, embankments, cuttings, etc. and show dark. Light gauge railways have much sharper curves and pit contours closer. The only scope for concealment is spurs and dummy lines.

Canals are regular waterways with locks while rivers serving as communications have wharves.

Cables show where earth has been turned and reveal fairly regular lines and sharp junctions and are usually continuous lines in the opposite sides of obstacles such as roads which break them.

Air lines show the spoil where the posts have been dug in, as regularly spaced spots as in a straight line irrespective of obstacles.

Railway stations, railway lines, wagons and carriages, garages and cars as well as harbours, bridges and roads are singled out for air attack to dislocate communication and transport system. Railway stations are very large structures and it is difficult to disguise them by painting or by deformation. Some odd eye-striking feature could be concealed. The different units could be toned down, to keep within the surrounding tone.

In Hamburg the Binnenalster lake was covered with floating structures, piles being driven into the water. Huge rafts were put out in the lake to represent streets, houses, etc. A replica of a bridge was built about 600 yds. north of the real bridge and the railway station had "road" painted across the top of it. Little wooden houses were built and trees were set up to give the tell-tale stretch of water, the appearance of a part of the city.[1] The Potsdam railway station has also received camouflage measures.

Even if the railway station is camouflaged, it is difficult to conceal the lines and roads leading to it. Merging and disruption by painting and concealment by netting should all be used to disguise it. The railway line for some distance may be concealed by netting but a dummy line should be laid to mislead the

[1]The "Mail", 4-10-41.

enemy. Since railway carriages are machine-gunned, dazzle-painting could be tried as was done in France in the last Great War. Oil tank wagons could be covered by opaque material and made to look like passenger carriages.

A dummy line provides the best solution to the railway line and dummy bridges might be erected at strategic points. Roads are difficult to conceal over long stretches and dummies, as already suggested, should be tried to divert attention.

It is reported that after years of experiment, a New York inventor has perfected what he believes is the most satisfactory anti-aircraft camouflage for highways, also for air ports, bridges and other structures.

His invention consists of a coloured paving substance, similar to asphalt, which blends road or building surface with the surrounding colour scheme. Dark greens, greys and browns are the chief colour combinations. The material is said to be cheap to produce, long-lasting in effect, and easy to apply.[1]

Strands of rope and straw might be used to cover canals leading into important objectives. But unless done over fairly long distances, the airmen would detect the position. A harbour is located by the large number of buildings by the roads and rail leading to it and by the piers and the jetty. Toning down and concealing the important units by netting and extending the ground pattern by disruptive painting, alone are practical. It is idle to merge the entire area into the sea and finances may not permit the expensive Hamburg experiment. The railway lines and the roads should be camouflaged if not diverted, and a dummy harbour should be conspicuously shown at a safe distance to mislead the enemy.

Motor vehicles have also been subjected to machine-gunning and measures are taken to camouflage them. In Great Britain all army and other service vehicles are painted in a dull jazz pattern to render them less visible from the air. Power is given to the authorities for prohibiting the use of vehicles on roads unless camouflage measures are adopted to diminish visibility. The Ministry of Transport has recommended to owners to repaint their vehicles to make them less conspicuous by using dark neutral shades

[1] The "Hindu", 2-11-41.

but not grey and khaki which are generally adopted for service vehicles. The jazz system is also not to be used. In normal circumstances in daylight, main roads are clearly visible from a height of 2,000 feet. It is easy for dive bombers to machine-gun

A Camouflaged Motor Car

motor vehicles. The best method for camouflaging vehicles is to use a variegated pattern of black, green and brown. Difficulty arises since different treatment is required for the town and the country. For this reason, there has been developed in Great Britain a system of camouflaging a vehicle differently in the two parts.

WATER.—Camouflage of water is a difficult problem, and the greater the extent, the more difficult it is to conceal successfully. Attempt should be made since large sheets of water serve as conspicuous landmarks. The tone of the surface varies with the view of the observer, the position of the sun and clouds. Aluminium sheets could be used with advantage, to create the illusion of an altered course to flowing water. Nets might be suspended along each bank to help to narrow a river and alter its shape and this could be made more effective by anchoring or tying rafts across the river with bushes, trees, etc. thrown over them.

Still water could be more effectively tackled. Nets, plain or garnished, could be used to alter the shape. Small patches could be completely concealed by an overhead cover of nets. Rafts covered with chittai toned down to merge with the surrounding landscape, liberally scattered over with muttee, creepers, plants, etc. could be floated where the area is large. Plants, small trees and bushes that

float on surface might be encouraged as also water weeds. Drainage might be attempted wherever possible. Any method attempted for concealing water should pay heed to changing weather conditions.

Conclusion

A most elaborate camouflage scheme may not secure safety if the location of the building is disregarded. Treatment of objectives without regard to the landmarks and neighbouring structures cannot be as effective as when the different units in an area are treated as parts of one scheme and the arresting features of the landscape toned down. A regional treatment should take into consideration.

1. Zones surrounding vital factories.

2. Zones including landmarks to vital factories.

3. Zones containing vital essential services such as water-supplies, electricity key points, headquarters, etc.

4. Landmarks to navigation.

Landmarks reveal the position of objectives close by. When British heavy bombers raided Milan on December 18, 1940, the Pirelli Works, which held large stocks of rubber and well known for the manufacture of motor stores, went ablaze. The Air Ministry News Service explaining the reason pointed out that they are peculiarly vulnerable to air attacks, since they lie between two conspicuous railway systems and can be recognised with comparative ease. Landmarks which need our attention may be factories, cooling towers, barracks or similar large structures, rivers and canals, harbours, chimneys, clock towers and roads and railway systems.

A long river or a broad channel is equally a dangerous pointer. Night raiders in Zeppelins over England during the last war were easily guided by the Thames to the position of London. The phosphorescence of waves reveal the position of harbours however perfectly blacked out at night. The glow or phosphorescence of the sea is caused mainly by millions of microscopic marine animals. They emit light when oxygen is dissolved in the water, as by stirring or by the breaking of the waves. It contains those colours that convey a strong impression of light

to our eye such as, in particular, yellow and green. Measures have not yet been devised to eliminate this phenomena.

Further it is difficult to maintain the correct colour, tone and texture of paints used in camouflaging objectives, throughout the year. In monsoon months a shower would make the paints glisten. Every colour, if wet, is twice as brilliant as it is, when dry. As soon as objects are covered by a thin film of water, their surface becomes smoother, they no longer scatter white light on all sides, and therefore, their own colour predominates and becomes more saturated. Rain alters the colour of the ground altogether. Street cobbles reflect more strongly the more steeply our gaze falls on them. Not only asphalt, but also very uneven paved roads, can reflect splendidly at large angles. The colours of roads, of sand, soil and gravel grow darker and warmer. A pool of water on an asphalt road reveals beautiful shades of colour. Great care should therefore be exercised in the choice of camouflage paints.

The importance of location is, therefore, stressed for all future erections of buildings etc. in the interest of safety. Since the policy of the Government of India is towards industrialisation a Siting Board should be established so that suitable sites could be selected for the location of new and growing industries. This will encourage building industries in healthy localities and if they are properly sited they will minimise the expenses of A.R.P. and camouflage measures. This will make our centres of production, safe in times of peace an l war. Space and vegetation[1] around an objective are very helpful to concert effective camouflage measures, and wise spacing of all important buildings and objectives is, therefore, necessary to assure chances of escape. Flying at a tremendous height, a bombing machine is likely to release bombs haphazardly over an area in which the objectives are known to exist. The greater the proportion of unbuilt to built-up areas the more are the chances to escape direct hits. It the objectives were in open country and enemy planes happen to be passing over that country, it is certain that, without camouflage, they would descend low enough to attempt a direct hit and would probably succeed. In such circumstances, camouflage would be worthwhile and very effective.

[1] Authorities in India have already realised the value of trees for effective camouflage treatment. The Government of Madras has drawn public attention to this question in a Press Note.

Our accepted methods of architectural grandeur is not conducive to effective camouflage treatment.[1] Tall clock towers, water towers, minarets and very prominent skyline features considered necessary to add grandeur to structures are not amenable to camouflage treatment. Smoke, suggested by some to envelop them, has been criticised by the opposite school, who point out that smoke areas would invite the special attention of the bombers; moreover, weather conditions might make successful enveloping impracticable. It is, therefore, suggested to leave out all objects rising above a large factory or building, for it is useless to attempt to camouflage them. "Leave these objects standing and camouflage the rest of the factory, so that from the air one would see a hay-stack, water tower and a clock tower, but the vast area of the factory surrounding these objects would not be related to them."

Many buildings by their design and construction cannot be concealed easily. Camouflage in civil defence will become more successful if in the future the architect, the builder, the artist and the naturalist combined and carried out research, thoroughly on all possible forms of concealment. Considering the fact that the aeroplane, motor car, etc. have improved in efficiency as also in pattern, building design could improve combining æsthetics as well as security.

Architectural æsthetics directed towards security is bound to give us buildings and structures pleasing and at the same time secure.

OBSCURATION OF LIGHT

If camouflage is adopted to reduce chances of attack during day, drastic lighting restrictions are attempted with the intention of reducing the risk of destruction at night. A night raid is particularly disastrous and difficult to resist and lights are useful pointers to the night bombers. Black-out as it is usually styled came into vogue even in the last War when Zeppelins began to raid London.

The aim is to secure that as far as is practicable, hostile air-craft passing over the country at night would see no light which might

[1] Whitewashing adds to conspicuousness of objectives. All important structures should by colour wash be toned down within the surrounding tone as indicated by a communique issued by the Government of Madras, recently.

serve to guide them to a particular objective or assist them to determine their position.[1] The restriction accordingly impose general darkening as a permanent condition from the outbreak of war. Drastic lighting restrictions now form an important feature of the precautionary measures taken as a form of security against air attacks.

They cover,

1. The masking of all windows and skylights and doors at night, of all occupied premises to prevent light inside from being visible from outside, and the prohibition of external light.

2. The prohibition of all illuminated advertisements and signs except those for A.R.P. purposes.

3. The screening of all windows and skylights from factory buildings with dark blinds or paints.

4. The elimination of normal street lighting although means for aiding movement in darkened streets by reflectors, white markings, or dim, well-screened indicator lights which cast no appreciable illumination, are permitted to mark the line of the road and also obstructions and danger points.

5. The control of lighting for essential services where absolutely necessary.

6. The restriction of lights carried by road vehicles and the screening of interior lighting in public vehicles.

7. The restriction of lighting in trains and on railway premises.

8. The control of shipping, navigation, and air-craft lights.

Without legislative compulsion it is impossible to do all these, and obscuration of light is therefore included in the Civil Defence Act of Great Britain.

Street lighting is vigorously controlled, lighting from shop windows and residences must be obscured by opaque shutters or black-out paints. Motor cars must use sidelights only and trains are also run with as little light as possible. Their head lights must be closed when they approach any metropolis so as to make its position less obvious.

[1] Home Office A.R.P. Circular 14th February, 1938. Memorandum on Lighting Restriction.

Table of Emergency Lights

Light or Illuminated sign	A R.P. Circular	Specifications	Mounting height	Candle-power	Brightness		Illumination at road Level foot candles	Requirement at distance	
					Candle per square foot	Equivalent foot candles		100 feet	250 feet
Street Lighting ..	344/1939 S.R. & O. 1940 No. 74	B.S./A.R.P. 37	9′ — 19′ and upwards	0.015 — 1.500	—	—	0.0002 — 0.0004	—	—
Traffic Signal ..	Memo—Aids to Movement S.R. & O 1940 No. 74	B.S. 505/1939 Electric lamp B.S. 555/1939	7′ 6″ (centre of lowest optical system)	Lumens (510 — 535) electric lamp	—	—	—	—	—
Traffic Sign (Mandatory and Prohibitory)	Memo—Aids S R & O. 1940 No. 74	—	—	—	Order of 0·1 (for Lettering)	—	—	Legible	In-conspicuous
Advance direction Sign, etc.	Memo—Aids S.R & O 1940 No 74	—	7′	—	(Order of 1 0)	—	—	,,	,,
Bollard (Panel) ..	Do.	—	—	—	—	—	—	Clearly visible	,,
Refuge Light (White Cross)	259/1939 S.R. & O. 1940 No. 74	—	—	—	not exceeding 0 5	—	—	—	—
Obstruction Light (Red)	Memo—Aids S.R. & O. 1940 No 74	—	—	not exceeding 1.0	—	—	—	—	—
A.R.P. Sign ..	S R. & O. 1940 No. 74	B.S./A.R.P. 32	8′	—	—	0.04 — 0.10	—	Clearly legible	In-conspicuous
Fog Flare ..	S.R. & O. 1940 No. 74	—	—	—	—	—	—	—	—
Hand Lamp ..	S.R. & O. 1940 No. 74	B.S./A.R.P. 3	—	not exceeding 1.0	—	—	—	—	—
Hand Torch (or Lamp)	S.R. & O. 1940 No. 74	—	—	not exceeding 1.0 (Dimmed by two sheets tissue paper)	—	—	—	—	—

In page 407 are indicated the principal types of emergency lighting permitted in the streets, together with the values of candle-power brightness or illumination allowed.

Extensive tests have been made, some of them covering several thousand square miles and at huge cost, to test the effectiveness of these measures. While the value of preventing lights from illuminating the targets below, which would aid the airman, cannot be minimised, experience has disclosed that strict enforcement leads to several disadvantages. Measures to counteract these thus become an essential part of the scheme of black-out in any country, and several remedies are being adopted in Great Britain by the Government and the people. A careful study of these measures is essential and particularly valuable to our country where black-out regulations are rapidly extending over the land.

The most serious disadvantage disclosed by experience is the increase in traffic accidents. Strict black-out regulations entail great hardship for the pedestrians as well as drivers of vehicles and traffic accidents rapidly rose in Great Britain.

Road deaths more than doubled in the first month of its operation ; 1,130 persons were killed in accident in Great Britain in September 1939 compared with 672 in August 1939.[1] Petrol was since then rationed and speed limit was more stringently controlled. Still hundreds of people were killed. October claimed 919 victims in the roads of Great Britain and November 1939, 926, while in November 1938, only 613 died. For September, October and November 1939, black-out deaths alone have been reckoned to total 674. 895 people were killed in December 1939. This is 212 more than those killed in December of the previous year. Official figures. show that 1,155 were killed on roads during December compared to 683 during the year before. The total is considered highest on record for any single month, black-out contributing 895.

During the period September 1 to December 31, 1939, namely, the first four months of the war 4,133 persons, including 2,657 pedestrians, died from road accidents, compared with 2,494 in the corresponding period for 1938. In January 1940, 619 persons lost their lives on roads of whom 461 were killed in the hours of darkness.

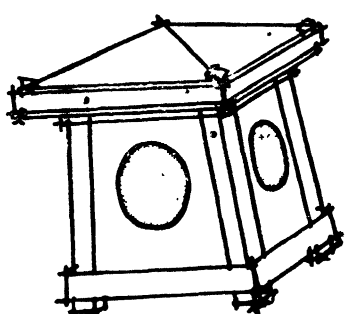
[1] Statistics of road accidents published in the " Hindu ". The battle of the Black-out, the " Hindu," October 29, 1939.

An increase of 134 or some 28 per cent. over the figures of January 1939. . Twenty miles speed limit was imposed from 1st February 1940. A decrease, has been registered for the month of February, 419 deaths, which mean 44 less than in February 1939. The reasons given are, the 20 miles speed limit ; the publicity campaign for greater care ; the snow and ice which reduced traffic during the earlier part of February, and rationing of petrol ; features upon which we cannot always count for road safety.

The problem of fast moving trains is more serious. Apart from the possibility of fast moving vehicles getting into accidents by bombed and shattered railway lines, there is the danger of collision. Train accidents have enormously increased in Germany after the advent of the black-out. They have also occurred in England. The first officially reported train accident happened at Bletchley. It cost only four lives and four carriages but it is a sufficiently grave sample.

Interesting devices are adopted by individuals to escape road accidents. Some have adopted white collars, hat bands, belts, umbrellas, etc. to make them easily discernible by the motorist. Some cyclists put on white stripes to their coat backs for the same reason. And lonely trownspeople evacuated to the country keep dogs to guide them at night.

Vehicles are also painted to facilitate recognition. Cars were painted with white lines in Sweden. White stripes are generally put on the mud guards. Obstructions in the roads such as pillars, etc., are also painted white or with white stripes to avoid colliding with them. A. R. P. Lanterns specially designed for illuminating street islands, pedestrain crossings, etc. are available in Great Britain. One type is in reinforced, fine-finished cement-sand concrete, provided with air-inlets in base The lamp within is fitted with a long time burner, giving continuous light for seven days,



A.R.P. Lantern for indicating shelters, refuges, traffic signals

168 hours, without attention, on one fuel charge of $1\frac{1}{2}$ pints of paraffin oil.[1]

Aids to movement are daily being evolved by the Ministry of Home Security to get over the dangers of night travelling.

With a view to minimising the risks of accidents arising from motor vehicles colliding with street refuges under black-out conditions, the London Civil Defence regional authorities have requested local authorities in the region to adopt a uniform road marking to indicate the presence of such refuges.

This marking takes the form of a white line along the centre of the roadway, starting thirty feet from the refuge. At twenty feet from the refuge the line bifurcates, forming two forms of a " Y " until the refuge is reached. The arms of the " Y " are joined at intervals of three feet by cross-bars of white stripes.[2]

The dangers of collision with sandbag walls or lamp posts in black-out could largely be avoided if obstructions are treated with paint containing phosphorescent powders throwing off light to warn pedestrians. Certain powders glow for several hours after exposure to the mercury vapour lamps. This property is now being utilised in warning lights for black-out nights. The glow-worm technique as this is popularly called is adopted for various kinds of traffic signals, dials and instruments. Luminous paints are coated even on the overcoat and helmets of policemen guiding traffic. These show only when the rays of shielded car lights fall upon them.[3]

An apparatus has been invented in England by means of which motorists will be able to see in the dark, without any light being visible from the air. The apparatus, weighing about 10 pounds and taking up little room, is worked by a motor-car battery and projects an invisible ray which illumines all surfaces previously treated with a special liquid. If kerbs, signposts, grass verges and the rear of vehicles are coated with this liquid, which is inexpensive

[1] Other models are also made, for Shelter Indicator, for Interior Illumination, for Military Road Blocks, for use with Main Electric Supply, for General Utility Purposes.

[2] J.I.M.Cy.E., Vol. LXVI, No. 8, p. xix.

[3] They are stationed at various points and in one case luminosity failed and the policemen, who remained completely invisible had several escapes from being run over! " Hindu ", 11-7-1939.

to produce, motorists equipped with this invention can travel safely and speedily at night, it is claimed, even if all other lights are extinguished.

The invisible ray would render objects on which it was directed brightly luminous for a distance of 200 feet. At present the necessary mechanism is said to cost about £16 to produce.[1]

In spite of all these as the "Times" pointed out regarding black-out accidents in England, "the list of casualties which we inflict on ourselves on the roads reads like the list of casualties inflicted by heavy and prolonged air offensive by the enemy."

Many other difficulties have also come to light, such as strain, depression and risk of lawlessness.

The damage to health is also mentioned and it is pointed out that sudden switching off of light might lead to panic and normally avoidable accidents. For the eye takes some time to adjust itself to marked changes in light. In some factories black-out arrangements have resulted in shutting away daylight through the windows with consequences easily imaginable.

Black-out has caused excessive strain to the eyes. Many ambulance drivers in London who have to drive at night, have to use eye-masks, soaked in eye lotion, in moments of relaxation.

The depressing feeling which enshrouding darkness creates upon the minds of the old and the young should also be reckoned, while the increased scope for certain classes of criminals who are helped by darkness is really deplorable. Statistical evidence have not been made available, but the risk may become practical when black-out conditions get settled.

Strict enforcement entails not a little expense. The experiment held in August 1939 covering over half of England on an area of 27,000 sq. miles came to £150,000. In the Metropolitan area of London alone 20,000 special police constables and war reserve officers had to be engaged!

It also leads to hardship. During the first three months in Manchester "1,060 have been charged with offences against the Lighting Restriction Order and almost all of the number have been fined."[2]

[1] "Hindu", 4-6-1939.
[2] "Illustrated Weekly of India", January 21, 1940, p. 11.

These are the disadvantages in time of peace, but others may crop up during actual raids. Complete black-out will necessitate more number of shelters in the interests of accessibility and the additional cost on this account would not be small. Further this will hinder the efficient functioning of A.R.P. services during a night raid, and an instance is already on record that fire during black-out could not be immediately and successfully dealt with.

As the London correspondent of the "Mail" writing in April, 1941 stated "London's West End Clubs have suffered so severely in raids that it comes as an added shock to clubmen when one of them succumbs to the ordinary risks of fire. These risks are aggravated nowadays by police insistence on a rigid black-out which often prevents flames being detected from outside until they have obtained a firm hold in the building. This is what happened in the case of the Bath Club, one of the few institutions of the kind in London which still boasted of a waiting list." [1]

To overcome the difficulties entailed by black-out it is suggested that lights should be arranged so that they could be switched off when the warning of a raid is announced. It is claimed that in Moscow "in the event of an air raid, lights can be switched off in quarter of a minute." It is also reported that "New York's quarter million, street lights can be turned off in any black-out emergency." The 28,000 control boxes installed in the city were adjusted by 12,000 electricians.

Arrangements to extinguish all street lights on the receipt of a warning to obviate the difficulties of a permanent black-out will involve considerable amount of electrical work which cannot be rapidly carried out in times of war and due to limited supply of labour and materials. This system presumes that warning can always be given. But the air raid wa rning system is not automatic. It depends upon many human and other uncertain factors and we must be not lulled into a feeling of security if there is no warning. As Mr. Herbert Morrison has declared that we are "not sure that experience in that city (Moscow) is relevant to conditions in this country."

The question of "lights till sirens go" adopted in Russia, to overcome the disadvantages of black-out has been examined by British authorities, and Herbert Morrison's observations need

[1] "Mail", 13-6-1941.

careful consideration. "The scheme is likely to lead to an increase in road accidents, because the vehicles would continue in the roads in the dark after lights have been suddenly extinguished." The mass switch device by which all lights can be put out has not therefore been adopted in Great Britain.[1]

More than two years ago Sir John Anderson as Home Secretary examined this question and rejected the idea.

His statement,[2] dealing in detail with the difficulties with which the Government were faced in considering the question of modifying black-out restrictions pointed out "only in a few towns, it is pointed out, can lights be extinguished from a central control. In most towns lamps are lighted individually, and the conversion of these lighting systems to enable lamps to be extinguished centrally would involve many months of work and cost millions of pounds."

He further pointed out that if, on receipt of an air raid warning, lights were suddenly put out, people would be plunged into a blackness which would create confusion and might cause panic in the streets. Moreover, it has been proved by co-operation with the R.A.F. that ordinary street lighting in a built-up area can be seen by hostile air-craft as far away as forty miles, and switching off lights on receipt of a public air raid warning would be an insufficient safeguard, since by that time the raiders might have come within sight of the area.

Apart from this consideration, the statement declares, lights would have to be extinguished on receipt of the preliminary warning which is received some minutes earlier than the public warning. That would mean that the confidential preliminary warning would be converted into a public warning, with all the dislocation and interruption of industrial activity which that would entail. An arrangement which would constantly put areas under public warning on occasions when no raid developed "would undermine public confidence and would seriously impair the productive capacity on which the country's war effort depends."

These difficulties, Sir John Anderson concludes, would not be overcome by reducing the intensity of street lighting, since even modified street lighting is visible to air-craft at considerable distances, particularly in favourable weather conditions.

[1] "Hindu", 11-10-1941.
[2] J.I.M.Cy.E., Vol. LXVI, No. 11, p. x.

Since then experiments with a view to devising a type of modified street lighting of very low intensity which would not be visible to raiding air-craft and could be left alight even when a raid is in progress are being attempted by the Home Office of Great Britain. Still Sir John's observation holds good since by the types of lighting so far tested have failed to satisfy the conditions required; "I cannot hold out any definite hope at present that it will be found possible to devise a type of lighting which will prove satisfactory, but further experiments are in progress."

To avoid the disadvantages of the black-out and at the same time to secure its advantages the creation of a canopy of glaring lights over a city has been suggested by an outstanding authority on out-door lighting who considers that it would afford better protection than a black-out in the event of invasion.[1]

This is to be done by the installation of numerous small though powerful searchlights, pointed upwards and mounted on the roofs of large buildings and at high elevations. Such a glare of light would tend to blind enemy flyers, prevent them from seeing through the curtain of light and locating vulnerable targets.

Such a canopy is believed to silhouette bombers to the eyes of defending air-craft flying in the sky above the heavy bombers. Such lighting could also be used to decoy enemy pilots by being placed about open fields adjacent to a city, thus extending what would appear the boundaries of the city as viewed from the air.

Mr. Dickerson points out that Nazi pilots now engaged in night raids on London and other large English cities have apparently had little difficulty in finding them in the black-out. Moonlight reflecting from the roof-tops, and from such rivers as the Thames plus parachute flares, have helped the Nazi raiders in locating vulnerable targets. Even without moonlight, such cities as London, Birmingham, and Manchester have a different reflection from that of the surrounding country and therefore can be detected from the air. The black-outs, plus cloudy and misty atmosphere, have helped the Nazi raiders hide in the night sky, making it difficult for English pilots to find them. He, therefore, believes that by installing these small, powerful searchlights not only in the cities but also outside the urban limits in rural areas, the enemy might be decoyed into

[1]A. F. Dickerson, Head of General Electrics' Illuminating Laboratory. *Vide* 'The American City', July 1941, p. 15.

unloading his bombs on unimportant ground. This idea is well worth exploring, but to most Indian cities would not be feasible since it would prove very expensive and in many cases not possible.

As things are at present black-out cannot be divested of difficulties and dangers. Since the advantages it offers are too precious to be ignored, the only way open is to concert measures to minimise the evils, along with measures to enforce lighting restrictions.

After a careful consideration of all the factors involved, the Government of India have decided that a permanent black-out is unnecessary in India and that the obscuration of lighting is more suitable to conditions obtaining in this country. It is also decided that the imposition of sudden complete black-out on the receipt of an air raid warning is impracticable.

" Obscuration means the reduction of the power and number of lights to the absolute minimum, and the screening or shading of all remaining lights so that no light is cast above the horizontal and no appreciable light is reflected on the ground, with the general effect that, at best, all lighting becomes invisible to the enemy, and in any case no particular target can be singled out for attack."[1]

Therefore black-out regulations in India are so designed that lights will be so obscured in the streets as to allow their beams to fall within a limited area directly under the lamp, while lights in residential quarters will be so covered as to allow no beam to pass beyond the doors and windows.

Obscuration of light is now in force not merely in the coastal cities and towns but in many interior towns as well.

Black-out exercises have been held in different parts of India ; in Lahore, Amritsar, Sialkot, Gurjanwala, Wazirabad, Gurdaspur, Dalhousie and Pathankot and other towns of the Punjab ; in Bombay, Calcutta, Madras, and other provinces. Lights are also dimmed at the Railway Stations.

Stiff black-out tests have also been proposed by the Central A.R.P. Organisation in India—72 hours' continuous black-out in cities vulnerable to air attack. Under the scheme, it is proposed to cut out street lights only, allowing electric current to residential quarters.

[1] *Vide* Government of India, Handbook No. 3 " Technical Air Raid Precautions in India."

Lighting restrictions apply to all kinds of buildings and structures, to street lights, as well as to the Railway and Transport system in vulnerable areas. They also apply to the cremation of bodies during night in some cities.[1]

The Government of India permit members of the public to use electric hand torches during black-out after the air raid sirens have sounded the " Alert " provided that the aperture through which light is emitted is not more than one inch in diameter and the light is dimmed with a piece of paper to that extent.

Air Raid Wardens have been asked to advise the public to use torches as little as possible, especially in crowded places and particularly when ' enemy ' air-craft are overhead. Economy in the consumption of batteries should also be stressed. These regulations do not apply to the hooded lamps known as A.R.P. hand-lamps and the use of these hand-lamps are permitted after the ' Alert ' only in the case of police and civil defence workers and other persons who are permitted by the police to use them for essential work.

Conditions in Indian cities and towns differ from those of English urban areas. Domestic and street lighting, road sense of the public, and traffic control measures, etc., vary from place to place. Already even the ' partial ' obscuration enforced in Indian towns has begun to entail hardship upon the citizens as well as civic authorities.

Shading the lights have entailed expense to Municipalities.

Prosecutions for non-compliance with the A.R.P. lighting rules have loomed large in the police courts in Bombay. Thirteen persons were charged on 11-7-1941, before the Presidency Magistrate, Esplanade, for non-shading or insufficient shading of their lights.[2]

[1] The Commissioner of Police, Bombay, has forbidden the cremation of bodies between 5 p.m. and 6 p.m. or the keeping of any funeral pyre burning after 8 p.m. There will, however, be no objection to the conveyance of bodies to the burning ghats before 6 a.m., says a Press Note.

Reconnaissance from the sea has shown that fires lighted for the burning of bodies during the hours of darkness are visible at a great distance from the shore and also from the air. Such fires would be of assistance to the enemy and, in the interests of public safety, the restrictions have been imposed. It is expected that those concerned will co-operate in carrying out a measure imposed by public necessity. No serious inconvenience will be caused to the public since the conveyance of bodies to the burning ghats—without the carrying of any lights—has been allowed during hours of darkness. The "Hindu", 28-3-1942.

[2] " Hindu ", 12-7-1941.

In Madras during the month of July 1941, over 1,000 motor cars were brought to the Traffic Office Headquarters for defective observance of lighting restrictions and their owners were warned and given instructions as to the proper way of screening lights.

On the first day of August, 1941 alone, as a result of checking by traffic sergeants, about 170 motor vehicles were found with improper lighting arrangements.[1]

Soon after the lighting restrictions were brought into force about twenty persons were charged for failure to comply with the regulations regarding the domestic residences, in Negapatam.

Other disadvantages have also been pointed out. The Bezwada Municipal Council pointed out in a resolution : " Since the black-out was introduced, there had been several thefts, one murder, one case of attempted murder and many accidents on the road, and that therefore the Council was of opinion that the black-out was 'causing more danger than the expected danger' ".[2] The Council therefore refused to sanction the sum of Rs. 7,000 incurred by the Commissioner in connection with the black-out arrangements in the town.

A leading daily referring to some of the features of the black-out in force drew public attention to the disadvantages.

" And yet Madras too enjoys—or should we say, suffers ?—black-out, of sorts. By courtesy rather than from conviction, has come to be called the " partial black-out " in this city, one continues to wonder what its purpose is. This depressing camouflage had its origin in the early days of the war, when the menace from the air appeared to be the first concern of the defence authority and darkness seemed to be obvious first step in air raid precautions. Some half-measures were taken, in the shape of banning private illuminations, without their being shaded above and on sides, and hiding the street lights under miniature bushels. We do not know if these devices were found satisfactory from a military point of view, but the annoyance and danger they caused to the public have grown ; and the public's legitimate grouse has not been lessened by anomalies which, in course of time, crept into the enforcement of these restrictions."[3]

[1] The " Hindu ", 3-8-1941.
[2] The " Mail ", 22-11-1941.
[3] " Darkness and Defence," the " Hindu ", Editorial, 29-4-1940.

Since the very night of February 15, 1942, on which the black-out was enforced in Puri town for the first time, there have been several cases of arson and incendiarism in the thatched quarters of the town, causing widespread panic among the people. Detailing the measures taken to meet the situation, the communique of the District Magistrate, of Puri, stated that the affected parts of the town had been sub-divided into three blocks and a responsible police officer, with a number of constables, had been put in charge of each block for patrol duty both day and night.

A lawsuit concerning the liability of local Councils for black-out accidents came before Mr. Justice Humphreys in the King's Bench on August 19, 1941.

The suit was brought by Mr. Arthur G. Lyus Leytonstone, who sued Stepney Borough Council, claiming damages for alleged negligence or breach of statutory duty. Mr. Lyus claimed in respect of personal injuries received when he collided with a sand bin in Seattle St. on September 15, 1940. He alleged that the bin became a danger when the black-out restrictions were enforced, and the Council did not take steps to make it visible to pedestrians by painting it white. This was done about a month after the accident.

Until the War street lighting effectively showed up the sand bin, but under the Defence Regulations, the Council quite properly ceased to light the streets. The mere fact that the Council was absolved from its duty of lighting the streets, did not absolve it from any other duty which the Common law might impose upon it to see that people in the street were not unduly inconvenienced or had accident caused to them. Mr. Lyus was awarded a total of £190, including £40 spetial damages, and entered judgment for that amount and costs.[1]

This judgment of a well known judge of a well known judiciary makes very clear the responsibility of civic authorities to concert measure to overcome the difficulties of black-out. We will do well to remember that so long as light obscuration cannot be abandoned as long will aids to movement and several other measures remain indispensable.

[1] J.I.M.Cy.E., Vol. LXVII, No. 4, p. xii.

Appendix to Chapter X

Used in its broadest sense of deception, camouflage has been practised by the field forces in every country, and the Trojan Horse has its counterparts in Hindu mythology and history. Every kind of camouflage now adopted has its ancient counterpart. Some of the most ingenious devices described in the epics would make modern generals envy the ancients for sheer ingenuity.

Several sastras mention devices to enshroud the forces from the gaze of the enemy which may be compared to the smoke screen tactics of modern navies. Disguise of form and distortion of shape have their prototypes in the Asuras who assumed different shapes to mislead their victims.

Dummies recommended to frighten the enemy or invite him to waste his blows have their classic example in the Lord of the Lanka whose numerous heads in all probability represented a clever scheme to overcome the enemy's sword and arrow. Attempting to escape destruction by deliberately flying neutral flags and painting the Red Cross over military objectives are no more ingenious than the trick adopted by Arjuna's Charioteer in that immortal battle when he assumed the guise of a woman whom Bheeshma scorned to fight, and thus escaped Arjuna from the great warrior.

The strategic camouflage can find no better example than the ruse adopted by the Paṇdavas to kill their tutor, the unrivalled archer. Drona's heart broke when he heard of the misleading statement uttered to the effect that an elephant bearing his son's name was killed.

Camouflage for defence purposes was not adopted since there was no need of protective measures for civilian objectives during the war. But literature abounds in descriptions which indicate the ability of ancient craftsmen to produce illusory effects in buildings and structures. The halls erected at Indraprastha had unique features so that even at close quarters, the flooring misled the observer to be a sheet of water, while bathing pools inside palaces were so cleverly laid that their presence was scarcely noticeable.

The subject of camouflage in Ancient India is as large as it is fascinating and would occupy a volume if dealt with in detail.

CHAPTER, XI

A. R. P.
ORGANISATIONS AND EDUCATION

CHAPTER XI

A. R. P. ORGANISATIONS AND EDUCATION

It will now be evident that elaborate organisations are necessary to deal with damage caused by air raids and to help recovering from the blows dealt by bombers. They are also needed to check the spread of evil consequences and disaster. A.R.P. organisations, are built up in most countries threatened by the air arm. Since the need for Civil Defence Organisation to deal with possible air raids is now realised all the world over, even in distant Australia and America organisations have been formed. Black-out tests have been carried out in Australian cities, in Siam, in South Africa, Ceylon, etc. In May 1941, an office for Civilian Defence was established in United States with Mayor La Guardia of New York, at its head. President Roosevelt divided the new Defence Agency into two General Divisions, one being a Board of Civilian Protection to advise and assist in the formulation of Civilian Defence measures. The best known is that of Great Britain. Since Civil Defence is self-defence, the organisations are mainly voluntary, manned by unpaid personnel assisted by Government departments.

The A.R.P. Organisation or the Civil Defence Department co-ordinates the work of different agencies engaged in the following work.[1]

1. Air raid warnings, to provide as far as possible warning of impending air attack.
2. Lighting Restrictions.
3. Reporting damage. Information about the fall of bombs, including the presence of gas.
4. Police Forces, to supplement the regular police for emergencies. Fire brigades ; strengthening them, to enable them to deal effectively with the results of attacks from the air.
5. Rescue Parties, etc., to relieve the police and fire brigades and to rescue persons who are injured or trapped and to shore up dangerous walls, etc.

[1] *Vide* Home Office Circular "Air Raid Precautions", July 9, 1935, p. 45.

6. Treatment of casualties. Mobilisation and expansion of the medical and first-aid resources. To provide first-aid posts, casualty clearing stations, and hospitals for more extended treatment, together with an adequate ambulance service. Facilities for decontamination of gas casualties and their clothing are also essential.

7. Anti-gas services. Separate arrangements will have to be made for the decontamination of vehicles, buildings, and their contents and contaminated ground, as well as for the organisation of expert gas detectors who can determine whether a bombed area is free from gas or whether decontamination measures are needed.

8. Maintenance of essential public services. Public services such as water, gas, and electricity should be kept going at any rate on a basis of minimum requirements.

9. Road repairs and clearance of debris.

In the words of Capt. Liddel Hart, air raid precautions, cover " measures for the dispersion and concealment of works which may form likely targets ; the duplication of sources of essential supply, so as to limit the effect of damage to any one of them ; the evacuation of population so far as possible from specially endangered areas ; the provision of bomb-proof or splinter-proof shelters for workers in and inhabitants of such areas ; the organisation of emergency services to give warning of impending attacks, to maintain order, to clear debris, to deal with outbreaks of fire or the dissemination of gas, and to restore communications."[1]

Nation-wide organisations to deal with these problems have been set up in most European countries and A.R.P. has almost become part of the daily routine of the inhabitants of the crowded cities of Europe. A brief description of the British system would give us an idea of the fundamentals of a successful system. Her civil defence forces number a million and a quarter men of all ages and classes and hundred million sterling was spent upon civil defence alone in the first year of its organisation.

[1] Encyclopædia Brittanica : Year Book 1940, "Civil Defence".

Civil Defence in Great Britain

The Civil Defence Organisation of Great Britain is a national affair. It is managed by six Government Departments, 12 Regional Commissioners, 315 large Local Authorities, 1,200 small Authorities, and three million men and women.

The civil defence mechanism is based on the regional scheme and has been cleverly dovetailed into the well proved system of local Government through the councils and committees, the controllers of the local authority and the people. It has become an integral part of their national and local life. It comprises of fire-fighters, wardens, casualty services, rescue parties and so on. Highly organised team work becomes necessary, for, the streets are cumbered with debris, blocked with bomb craters, the muck and the smoke and the smoulder of escaping gas, smouldering fires and shattered buildings. Across these obstacles, essential transport and fire appliances are moved. Ambulances get back to the hospitals and first-aid posts, where the doctors and nurses tend the wounded. After a severe raid, the dislocation in the city is more than any town can cope with from its own resources and personnel. Houses over a large area have shattered windows and rooms. Some have their walls blown in, exposing the contents to the rain and dirt of the winter weather. Great areas in the city have no water supply, no gas to cook by, no light for the offices and workshops, let alone their homes. When the morning arrives, the civil defence personnel need relief and rest. The arduous task of bringing back to life a shattered city and rehabilitating its crippled limbs begins. Order is restored, unnecessary traffic kept out of the city, roads are cleared, essential services—electricity, gas, water, buses, drainage —are attended to. No time can be wasted. Water carts quickly come on the scene where the mains are smashed. Loudspeaker vans tell the public where to go and what to do. Communal kitchens are extended, for many have no cooking facilities. Scores of mobile canteens are drafted into the area. There is then the work of demolition of buildings tottering and unsafe, of billeting and evacuating the homeless, of effecting immediate repairs to damaged houses, of sending assistance to those who have lost everything in the world and have only the clothes they stand up in.

At the beginning of 1936, instruction classes were started and local authorities were advised to appoint A.R.P. Officers. Recruiting

on a national scale started with the A.R.P. Act of December 1937 and with the passing months, men and women from shops, offices and factories were fashioned into fire fighters, ambulance drivers, wardens and rescue and first-aid workers. The September crisis of 1939 gave a tremendous impetus. Recruits rushed to join the A.R.P. Services in a mighty tide. The institution of decorations was announced by His Majesty on 23rd September 1940. The organisation of civil defence is a vast and complex undertaking. Controlled by the Ministry of Home Security, there are twelve regional organisations covering the entire country which would work independently if the head-quarters is affected. Each region has a Regional Commissioner. London has three. The working of individual A.R.P. Services is under the immediate control of officers appointed by the various local authorities. The decision to sound an air raid warning comes from the fighter-command who issue, whenever possible, a preliminary warning to the control centre of the district. The A.R.P. Controller summons his staff into action by pressing a button. Telephone pass the warning to the report centre and to warden's posts. The medical services are notified. Intelligence Officers get ready to mark all movements on their maps. Telephone, gas, water and electricity officers become alert to receive and pass messages. If approaching raiders continue on their course, the fighter-command signals to sound the siren. Individual wardens and police take to their posts. The warden communicates incidents to the report centre and the complete machinery is set in motion. The report centre passes on the warden's communication to the control centre and from there orders are issued to A.R.P. depots according to the needs of the emergency. Rescue, first-aid and ambulance parties are despatched to the scene of the incident. In the report centre and the control room, they are supplied with as lucid an account as possible of what is happening and what is wanted. Reinforcements are sent when required.

No raid on England has been allowed to get out of hand. There has been no Reign of Terror such as Warsaw suffered. Fires have been fought and conquered in periods incredibly short, the injured have been saved, the debris cleared. Men and women have worked among the havoc of high explosives and defied the machine-guns of diving air-craft, burrowed to the rescue of the entombed under the threat of falling masonry and comforted the suffering, while

they themselves have suffered. It is impossible to describe what happens daily of firemen mastering a blaze, with bombs bursting about them; of rescue parties working against ghastly obstacle—indeed, against time itself—to reach people buried in debris; of ambulance drivers urging their loaded vehicles through the hell of *blitzkrieg* in the black-out; of first-aid workers bringing succour to the injured; of the people who operate mobile canteens, so that refreshment may be always at hand for their comrades.

And to these must be added a vast throng of unsung heroes, whose work is done just as diligently—wardens and shelter marshals; telephonists and street messengers; animal guards; office and factory staff; roof watchers and the rest.

Both the cities and the country-side are divided into clearly defined areas, each with its Control Post where Wardens are on duty day and night. Both men and women are enlisted some on a salaried basis, others voluntary; the full-time male wardens in Great Britain receive £3 a week. The women £2. Plans for reporting air raid damages are ready the moment a state of war exists; so the Wardens can be compared to the Royal Corps of Signals in an army on active service.

The Control Posts form the units of the organisation.[1] It is from these Posts the Wardens are sent out on patrol; it is with these posts that they keep in perpetual touch. Each Warden is as familiar with his own area as a policeman on his beat; it is his duty to make personal contact with the families that live in his area, and he gives them advice on a multitude of points connected with air raid protection. He examines the splinter-proof shelters provided by the Government or constructed by the individual householder. The lighting restrictions are his special care. And he has a dozen other duties, all of them connected with the safety of the civilians in his area. The Wardens are the eyes of the Control Posts by day and their feelers during the hours of darkness. Vigilance is their watchword.

[1] In the event of an emergency the London areas' Civil Defence Organisation is controlled from one central control room. On receipt of an air raid warning on the teleprinter, direct from the Fighter Command, the watch on duty immediately go to "battle" stations. From this room there is direct communication to all A.R.P. Group Headquarters, Scotland Yard, and the Home Office. From here the Operations Officer can transfer as many A.R.P. forces as necessary to cope with severe damage in any one quarter—this is known as "mutual assistance".

When the report comes through, that enemy raiders are approaching the boundary, the word is transmitted to the Control Posts. By the time the "Action Warning" comes through, every Air Raid Warden is ready. The undulating note of the sirens can be heard if the raiders continue on their course ; the whistles of the Wardens carry the news far and wide ; and when the raiders have passed, the sirens sound a long steady blast. If gas-bombs have been dropped, the Wardens' rattle proclaim the tidings, the public must continue to take precautions until the " All Clear " hand-bells can be heard in the streets. Wherever he goes the civilian carries his respirator with him ; so that every man, woman and child in England is ready for the signal of a gas attack.

It was under the A.R.P. Scheme that the great evacuation took place ; teachers, helpers, mothers, expectant mothers, cripples, blind people and hospital patients were conveyed from their danger areas. It was the biggest scheme of its kind that has ever been conceived ; nearly one million children apart from adults left the towns. Everything went through with an efficiency that was almost miraculous; and the power of the enemy to break down civilian resistance by air raids has been enormously reduced.

In cities and villages, First-Aid Posts and hospitals are prepared for casualties caused by enemy bombers. Rescue squads, first-aid parties, and ambulances are ready for instant duty. 200,000 new beds and mattresses were provided by the Government, and nearly one-quarter of a million stretchers.

Provision has been made for fires that may be started by incendiary bombs. Even the distant villages have their Auxiliary Fire Service with full equipment ; and under the A.R.P. scheme, public shelters have been provided at thousands of points in English towns. As for poison gas, no country could be free in Europe but none is in a better position to resist attack than England ; the Government have supplied gas masks for all and full instructions have been given to make suitable rooms gas-proof. By means of pamphlets that have gone out to millions of homes, by lectures, by radio-talks, and by the newspaper press, the public have been given copious instructions for their personal safety in an enemy air raid. By day and night the work has been carried on ; and the A.R.P. machine is now in motion throughout the land.

Provision has been made to deal with incendiary bombs and fires that might be started. In addition to the fire brigade, Auxiliary Fire Service manned by men and women have been organised on an extensive scale. Equipment to remove incendiary bombs have been distributed and instructions imparted to innumerable householders. The fire brigades carry on their work even during a raid and have successfully dealt with the fire raids of Nazi airmen. Provision for the supply of water to fight the fires by cisterns etc. have also been made.

Rescue parties and demolition squads as well as arrangements for removing debris and clearing the sites consisting of trained personnel and necessary equipments, exist in all vulnerable zones. The *blitz* has proved the great importance of this work in crowded cities ; repair of roads, demolition of dangerous buildings, restoring the supply of essential services cannot be done without these.

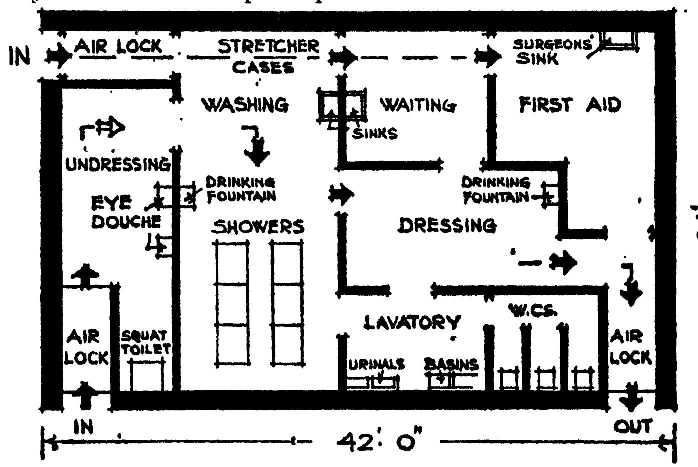
The Rescue Party is essential " to rescue living persons who are trapped in the wreckage, to recover the bodies of persons killed in the collapsed building, to temporarily shore up or otherwise provide support for the building so weakened that a further collapse is likely which would endanger life or obstruct an important roadway, or where necessary to demolish it ; and if necessary to salvage food stock buried under debris."

Decontamination squads consisting of trained personnel to deal with gas attack are also organised. Each party has necessary equipment to carry out decontamination work to buildings or roads affected by poison. Cleansing stations are provided in suitable centres to treat civilians attacked by gas.

The use of time-bombs by the Germans has necessitated the formation of bomb disposal squads to render the neighbourhood safe and save the structures closeby. A one-ton bomb was removed from the vicinity of St. Paul's by one squad headed by Davies and the Cathedral was saved, so also a German Hospital. Extremely risky but absolutely essential to save architectural treasures, these squads are manned by patriotic men who risk their life on behalf of the nation. The bomb is removed and carried to a safe place—a field or meadow—and made to explode.

Hundreds of tons of debris have been removed from the crowded parts of London and the problem of removing and salvaging and

stocking building materials and debris have given rise to difficult problems which the Borough and County Engineers are trying hard to overcome. The Ministry of Home Security have issued circulars to systematise and help the process.



A.R.P. Decontamination and First Aid Post

A separate organisation deals with evacuation and the allied problems. The free distribution of air raid shelters is made by the Government directly and through local authorities in Great Britain. Several non-official committees such as the A.R.P. Co-ordinating Committee also help this task in England.

It was under the A.R.P. Scheme that the great evacuation took place ; teachers, helpers, mothers, expectant mothers, cripples, blind people and hospital patients were conveyed from the danger areas. It was the biggest scheme of its kind that has ever been conceived ; nearly one million children apart from adults left the towns. Everything went through with an efficiency that was almost miraculous ; and the power of the enemy to break down civilian resistance by air raids has been enormously reduced.

It is under the A.R.P. Scheme public shelters were provided at thousands of points in English towns. It was under the auspices of the A.R.P. that propaganda was carried out to instruct the people. By means of pamphlets that have gone out to millions of homes, by lectures, by radio-talks, and by the newspaper press, the public have been given copious instructions for their personal safety in an enemy air raid.

In Germany, in Russia, in France, etc. and even in the peace-loving country of Switzerland A.R.P. Organisations have been set up long before the recent war. Precautions were afoot in France many years ago and a plan for evacuation was ready in 1930. The German measures and Polish regulations regarding A.R.P. for Buildings and Roads have already been dealt with in Chapter VI. It is claimed that Berlin's air defence and A.R.P. are organised with considerable skill as also those of Moscow. The geographical and natural conditions have succeeded in helping Chungking to possess an efficient A.R.P. system.

The principles and methods adopted in planning and executing schemes of A.R.P. are fundamentally similar although details and the degree of thoroughness may vary.

Air raid precautions will cost the local authorities in the metropolitan area of London more in the coming year. A sum of just over £7,500,000 has been spent by them in the year ended March, 1941 while the estimate for the next year is £8,000,000. Fire services alone cost the London County Council £1,147,120 which sum is expected to exceed one million and three quarter in the year 1942.

Fire Prevention and Fire-Fighting

An efficient fire-fighting organisation has now been found to be essential. In fact, fighting fire is the biggest job on the home front in Great Britain. Fires may leap up in a hundred places at a time. High explosives would thunder down. Water-mains may be broken and emptied, roads may be blocked by craters. Therefore 1,400 separate brigades were got ready in September 1940. Now the Home Secretary has authority over all the brigades of England and Wales. The Secretary of State for Scotland has similar authority over all the brigades in Scotland. The Ministry of Home Security operates through regional and sub-regional organisations. Many men have been called up for whole-time fire service and larger number for part-time service. As Herbert Morrison has emphasised, "the old proverb about prevention being better than cure is profoundly true of the battle of the flames." The army of fire-fighters has been greatly reinforced by the army of fire preventers, men and women who make it their business to put out the fire-bomb before it becomes ablaze. There are nearly

two million people for fire-bomb fighting, enormously easing the work of the brigades.

FIRE-PREVENTION: As Herbert Morrison emphasises, "not a single house or business must be left uncared for" to watch and extinguish the fire-bomb before it can begin its destructive work.

All male British subjects normally working within the city of London may now be required to register for fire-fighting duties. The order applies to all British subjects working in the city between the ages of 16 and 60 except for some specially exempted classes.

For the present, women are not compulsorily drafted, but Government reserve the right to call them if necessary. But women can voluntarily undertake work at once.

Under the "Fire-watch" service scheme every man under the age of 50 will be on duty for 48 hours per month in the neighbourhood of his place of work. Such a scheme is essential if our cities should not get burnt by incendiary attack.

One general method, although it is not very practical, is to shovel sand or earth on to the bomb which has the effect of extinguishing the burning electron metal by choking or smothering, that is elimination of air, and also insulating the heat.

One of the modern methods, however, now available for fighting these bombs is the use of inorganic salts which become molten in contact with them and choke the combustion of the bomb casing by excluding the air on the same lines as using a large amount of sand or earth. These salts can be used in concentrated solution, discharged from a hand extinguisher, or in granulated form by means of a "bomb snuffer" that is an iron hood arrangement carried on the end of an iron bar or handle which is clapped bodily over the bomb and releases a large amount of the powder which is contained in a carton in the casing melted by the heat.

FIRE-FIGHTING: The fire-fighting service (the Fire Brigades) thoroughly reorganised is reconstituted as the National Fire Service, since August 18, 1941. The new service is composed of 33 fire forces operating under an entirely new system of control. A Force Commander has all men and pumps in a whole area under his direct

control. Reserve camps are permanently manned and kept ready to move at a moment's notice, and are organised within reasonable distance of the main target areas. The National Fire Service has a quarter of a million men and is the largest fire-fighting unit in the world. The total membership of Britain's Fire Guard in residential areas and business premises amounts to several million men and women.

The fire prevention and fire-fighting services also extended to rural areas to guard Britain's cornfields with 12,500,000 acres under the plough—Britain's agricultural leaders have planned how to protect her corn crops from Nazi fire-bombs. Among the safeguards which may be enforced is the cutting of fire-breaks or lanes, about 30 ft. wide, across the direction of the prevailing wind. The crops, cut green, would not be wasted, but made into hay or silage. Corn stooks can be protected by setting the rows as far as possible. Ricks would be set at least 15 yards apart and, preferably out in the field, to prevent enemy landings.

For dealing with outbreaks of fire, water-carts would be kept filled near the standing crops, and further reserves, stored in ricks or van covers supported on stakes.

Fire-fighters will arm themselves with stirrup pumps, fruit spraying machines, liquid manure carts, wet sacks and brooms, cut from timber and hedgerows. With fire-watchers A.R.P. Wardens and Home Guards in every parish, there will be no lack of man-power to safeguard the vital harvest.

Roof Spotters

Roof spotters are essential to minimise the loss of output, of industries. As Mr. Arthur Greenwood admitted in the House of Commons, at the beginning, interruption of production during alerts had seriously affected output. Later the system of factory spotters reduced the amount of interference occasioned by the enemy action. Of course there remained loss due to actual damage or destruction of plant.

To circumvent stoppages or delay due to air raids either in factories or in offices, Roof Spotters are appointed. Except in the most exposed offices civil servants in London ignore the ordinary alert signal and carry on until the second emergency warning is

circulated when raiders are actually near. Even then the staff continue to work in shelters. The general object is to enable essential work to be continued, visitors to be received and important conferences to be continued.

Drastic reduction in the time lost through air raids has already been achieved by the "roof spotter" system, according to reports collected from factories all over the country by the Ministry of Supply. Many thousands of hours have been saved and firms employed on important contracts have overcome difficulties which arose when intensive raids first began.

Rescue and Demolition

Trained squads are necessary to "rescue living persons who are trapped in the wreckage, to recover the bodies of persons killed in the collapsed building, to temporarily shore up or otherwise provide support for the building so weakened that a further collapse is likely, which would endanger life or obstruct an important roadway, or where necessary to demolish it ; and if necessary to salvage food stock buried under debris."[1]

An idea of their organisation and working could be had by a study of the Rescue and Demolition Services in the London Region. The London County Council is responsible for the control and administration of Rescue and Demolition Service. The personnel of the service, which in the main is drawn from building trade operatives is organised on the following lines:—

Light rescue parties consist of ten men, exclusive of the driver, each party being made up of one leader or foreman, and three skilled men (tradesmen) and, in addition, six men responsible primarily for general assistance in the work of rescue, four of whom are trained to render first-aid.

Heavy rescue parties consist of eight men, exclusive of the driver, but including one foreman and three skilled men. Such heavy parties are provided with heavier type of equipment in order that they may undertake the more onerous tasks of rescue. In addition, arrangements are made on a county basis for a panel of contractors to deal with certain major damage beyond the scope

[1] *Vide* A.R.P.M.3

of normal rescue parties. Such contractors are required to enter into prime cost contracts on the lines of the model contract prepared by the Home Office.

The various boroughs may be likened to the "front line" of this branch of civil defence. The officers-in-charge of each case are usually assisted by two or three technical deputies, three technical assistants, five clerical officers, including pay clerks and two clerks of works per depot.

The average number of depots per borough is roughly four.

In addition to the general supervision and organisation of service in the borough, the officers-in-charge are responsible for the recruiting, training, allocation and discharge of personnel, accommodation, complaints, liaison through group to region, and the framing of exercises and their direction.

The technical assistants are responsible to the officer-in-charge for details of training and exercises, and reports; attendance at incidents during raids or exercises, the technical inspection of damage, details of equipment, vehicles, etc.

The clerks of works at the depots are responsible to the officer-in-charge for the discipline, equipment, stores, welfare, bedding, etc. and also the direction and co-ordination of teams at an incident and examination of work carried out after a raid.

Generally speaking, in addition to bricklayers, carpenters and plumbers, the following trades are now accepted as "skilled" men:—Riggers, mattock men, steel erectors, demolition men, timber men, painters, plasterers.

The terms of service within the metropolitan area are at rates £4 5*s*. for leaders, £3 17*s*. for three skilled men in each party, and £3 per week for other men in the parties, the twenty-four hours' shift being in operation generally. One meal to the value of 1*s*. is given for each twenty-four hours on duty; leave at the rate of one day for each complete month of service; three blankets and canvas strip per bed for each man. Boiler suits have been provided with distinguishing badges in the London County Council area, but the provision of a uniform type of clothing is under consideration in that area.

Generally speaking, apart from normal training, the trades unions recognise that the following works should be carried out

by rescue and demolition parties :—Work for men's comfort and protection and demolition works that will afford a " picture of bomb damage."

Individual training for leaders and others specially selected, is carried out in five schools in the London County Council Area (one in each group which also serves out-county boroughs)..

Schools deal with 175 trainees per week, and some thousands of trainees have been passed through the schools. Instruction is organised by the L.C.C. with a chief instructor and each school has two assistant instructors.

The course extends for five days, from 9 a.m. to 5 p.m. daily. Trainees are provided with a syllabus, and diagrams of knotting, shoring etc. so that when leaders return to depots they take with them sufficient information to train their own teams. After five days spent at the schools, it is generally found that the trainees develop a good standard of morale and discipline, which is gradually being carried into the squads.

The schools provide training in knotting and lashing, and the use of derricks, sheer legs, scaffolding, shoring, raking and flying; jacks, gyns, blocks and tackle; Rescue by lines, acetylene cutting apparatus; demolition by manual labour, and demolition by explosives. The syllabus of the course is revised from time to time, and an advisory panel of technicians has been formed to deal with this.

Team training is directly carried out by District Surveyors in charge of each borough. Co-ordination of training in and between groups is carried out by an officer, under the direction of Major Bax appointed for the purpose. Unlike individual training, it consists entirely of practical team work conducted out of doors by means of exercises. These exercises comprise :—

1. Squad training, to train men to work as a team under their leader and to teach leaders qualities of leadership and control.
2. Squad exercises, exercises of personnel in team spirit, and detailed knowledge and familiarity with the squad exercises under their leaders. To teach proper loading and manning of lorries and also care and cleaning of equipment and speedy response to instructions.

General responsibility for training rests with regional headquarters. District Surveyors make details of programmes to suit local conditions. Operational orders of exercises should be kept confidentially amongst the technical staff until the time of the exercise. Exercises need careful consideration, and are done by preparing a suitable number of " set " incidents on a card which act as an indication for the officer acting as instructor in charge of the exercises and umpire. On the back of the card is entered the considered solution and any points the umpire or instructor has to stress at a conference after the exercise.

Umpires are detailed for each incident for the purpose of :—

1. Recording times taken.
2. Notes of action of the squads for discussion afterwards.
3. Making full lessons of exercise known to directing staff and rescue and demolition personnel.

Before exercise begins squads are assembled at depots and are indicated the general idea of the exercise.

Skeleton exercises are carried out in or near the depot as a prelude to exercises in the borough area. These skeleton exercises are also held in grounds of a training centre or school.

Exercises in streets are held at a convenient location, which may be within a borough in the form of a derelict or deserted structure and conducted on the same lines as the skeleton exercise, with the object of gaining detailed knowledge of movement in traffic, swiftness of action.

Collective exercises are held embracing two or three squads, acting in co-operation under the direction of a clerk of works who is responsible for joint action, to learn co-operation between leaders of the various squads, simplification of reports back to depots and report centres.

In order to avoid boredom, six physical training instructors have been appointed to supervise physical training on a voluntary basis. Organised games are carried out on a league basis (football, boxing, etc.). Instruction is given at the various depots on boot repairing, wireless, internal combustion engines, and other subjects.

Salvage and Storage

Salvage of property, removal of debris, and the clearance of site, go together and form essential parts of A.R.P. work in any city. Plans must be laid and organisations got up for these purposes in advance. The work of salvage in Britain covers the following items :—

1. Assistance to owners of damaged property to recover and transport their possessions.
2. The protection and storage of goods belonging to absentee owners, premises being rented for this purpose, if necessary.
3. The protection and storage of commodities insured under the Government War Risks (Commodity) Insurance Scheme in so far as owners may have been unable to protect and store such commodities for themselves.
4. The recovery and disposal of food and useful materials.
5. The recovery and disposal of material under the Salvage Scheme of the Ministry of Supply operated by local authorities ; this scheme implies the sale of the material and the crediting of the proceeds to the person entitled, whether the original owner or the local authority to which the material may have been surrendered by the owner.

Such work of salvage is undertaken as far as possible by Civic authorities, Corporations and Municipalities and Local Bodies. Many of the purpose of salvage can be achieved only if the work is put in hand as soon as possible after the damage has been done ; if the whole of the operations necessary cannot be carried out at once, the first and most urgent stages should be undertaken. If the damage is so extensive as to put the necessary salvage beyond the resources of the civic authority request for help should be made to higher authorities and Provincial Governments, or to neighbouring Civic bodies with available resources. The Ministry of Home Security suggests preliminary conferences between these bodies so that help could be expedited in times of need. It further advises that higher authorities should be notified if the local authority does not intend to undertake even the first stages of salvage work.

The possibility of securing suitable premises for storage of salvaged property should be explored in advance and power should be obtained to requisition suitable premises during emergencies.

The removal of debris and the task of clearing sites disfigured by damage should also be immediately attended to to prevent the psychological influence, these will create on the morale of the people. Authorities should make such an arrangement for this work as they deem advisable and practicable. Expenditure on the work may be included in the claims for A.R.P. grant of the Central and Provincial Government as is done in Great Britain.

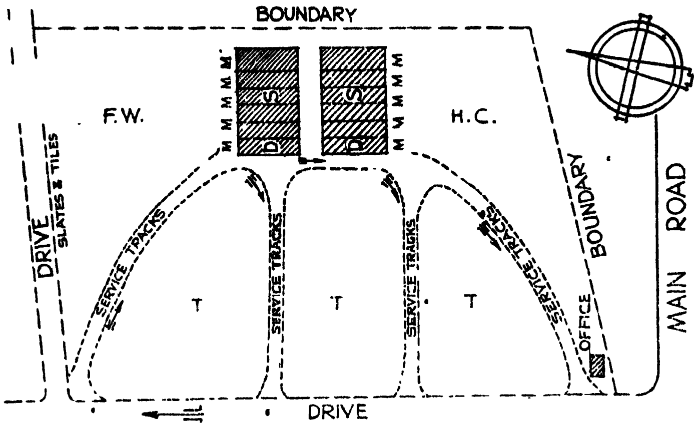
The difficulty of securing the necessary transport for the removal of materials, salved under the salvage scheme, may arise. The " stand by " rescue party lorries of the respective areas might be used. But this is not advisable for the routine house-to-house collection of salvage ; rather they should be used (*i*) at times of special appeal when the vehicles of the Cleansing Department would be unable to cope with the response (*ii*) for the conveyance of collected material from local dumps to a collecting centre or to a railway. Such vehicles must be subject to immediate recall for A.R.P. duties if the necessity should arise.

Considerable attention should be paid and plans made for the storage of materials salvaged from war debris. The bulk of these materials to be dealt with consists of timber, metal, bricks, doors and windows, sanitary fittings, etc., and a reasonable system should be adopted that will end in preserving and utilising them to their best advantage for repair and other work. Four main factors govern the problem. They are :—

1. Approximate amount of materials to be stored.
2. Sites available for this purpose.
3. The best methods of storing the various materials.
4. The most efficient and economical utilisation of labour employed upon the task.

The first is difficult to estimate as it depends upon the extent of bomb damage. And the sites chosen should be large enough to deal with present requirements. They must be decentralised as these dumps present targets for air-craft and are very vulnerable to

incendiary bombs. The site chosen should be as remote as possible from targets of any military importance although its position must not prevent its accessibility to the haulage vehicles which are necessary to feed it and draw supplies from it. The adjoining diagram would give an idea of typical site and lay-out.



typical lay-out for salvage depot[1]

The best method of storing depends upon local conditions and building materials, but certain broad principles could be followed to obtain satisfactory results and efficient working. The service tracks might be ten to twelve feet in width and so laid out as to enable the collecting and delivery vehicles to draw up within reasonable distance of all the stacks of materials laid out at various points on the site, in order to minimise the manhandling of these materials.

The service tracks should be constructed from hard core or stone rubble, from demolished houses. A corner of the site should be allocated to firewood dump, which although it cannot be neatly stacked as in the case of scantlings and boarding, should have its limits pegged out so that it shall not spread over the area, but tend to grow in height only. If space permits, it is a good idea to separate the small firewood, such as broken laths and matchboarding, etc., from the heavier materials, and thus form two stacks.

[1] T=Timber; M=Materials; H.C.=Hard Core; F.W.=Fire Wood; =Doors; S=Sanitary fittings.

The areas marked with the letter T could be used for the stacking of timber (soft woods) in their various sizes. The individual lengths should be kept about half an inch apart, while layers are separated by members running at right angles to the main stack. These stacks may be taken up to a height of from twelve to fifteen feet and approximately twenty feet wide. In some cases they may be separated by stacks of salvaged bricks and if this procedure is not adopted they are then kept about forty feet apart in order to minimise the risk of fire spreading from one to the other. Partly filled sandbags should be placed at each individual stack to be at hand should an incendiary bomb fall upon the site adjacent to it.

The ground adjoining the existing drive which bounds the northern extremity of the site may be used for the storing of tiles, etc. in their various sizes and categories.

All hard core should be deposited in one place preferably south east corner. Like the firewood stack its boundary should be pegged out and the heap made to grow as far as possible in height only. If successive layers are made to form a ramp, the delivery vehicles can then back-up this ramp and so deposit their loads at or near the summit.

Brick, timber, firewood, tiles and hard core would occupy the maximum space and need no covering or housing. But doors, windows and window frames, sanitary fittings, etc., need more care in housing and storing. Sheds could be put up at the extreme end of the site opposite the main road and the different kinds of materials stacked in different bays. Doors, etc., should be so stacked as to be fit to be taken out easily when required and there should be ample access for inspection and further storing. The size of these bays should be adjusted to suit the articles that may come up for storing.

It must be realised that the methods of stocking should not merely preserve the materials but give easy access to them and a passage way of at least 2 feet wide be left down the centre of the bays for this purpose.

Regarding the sheds they should be constructed from salvaged timber on the site and roofed with corrugated iron sheets. Separate stairs or portioned cubicles fit for the storing of metals after they have been sorted into their various groups, such as pipes, bends, gutters, sash weights, etc. should be provided. Salvaged

lead should also be stored in the main shed, well rammed to form a compact mass.

Duties upon the salvaged site should be allocated with great care in order to obtain satisfactory results, combined with economy of labour. The following workers are essential; store-keeper to keep stock-books up-to-date; working ganger or foremen; two men maintaining the stocking of sheds in proper order. Three men on timber and brick stacking, two men on metal sorting and storing and a driver and two men for sorting and delivering outgoing orders.

If materials on the site are allowed to collect without proper system of storage a great deal of additional labour would become necessary in order to carry out the sorting. The working of the salvage site will be greatly facilitated if the incoming materials are, to a certain degree, prepared on the demolition site, for storage. A close co-operation between those carrying out the demolition and those employed on storing the materials will minimise labour and greatly add to the success of the work.

For the purpose of stock keeping it will be a great help if each article in the sheds is marked with a small dab of red paint after being booked in. Local conditions will determine the procedure and details but the principles indicated may help in successfully tackling the problem.

War Damage Repair

We next have the problem of repairing structures damaged as the result of enemy action. This is work with which we have little previous experience. The Ministry of Home Security in Britain has issued an explanatory circular regarding War Damage Repair Procedure and several Borough Engineers have been adapting them to local conditions. Speedy execution is the fundamental requisite and would alleviate the distress and hardship of sufferers. As a result of experience it has been found advisable to carry out three separate surveys each for a distinct purpose. A preliminary survey should be carried out as soon as is practicable after the damage has occurred in order to carry out 'first-aid' repairs immediately. It will be a cursory inspection describing the property, location and type of damage. First-aid repairs should start immediately and must be given priority after rescue and demolition work has been

carried out.[1] The object of this should be to render weather-proof as many houses as possible within the first twenty-four hours. Care should be exercised in selecting premises, the more seriously damaged having been evacuated, can be left for a later decision. First-aid repairs, generally speaking, would cover those " which will quickly render property, wind and water-tight, including roofing and window protection by felting and reglazing together with minor joinery work, and in some cases items necessary to maintain the sanitary services."

The methods to be adopted depend upon the nature of the structure and building materials in use. Windows should be attended to first, then doors and the roof. It will be advantageous to resort to retiling, than adopting temporary covering. Damages to plaster if it happens is generally on a large scale and only first-aid patching up should be attempted.

Essential buildings include hospitals, first-aid posts, schools, bakeries, food factories, water works, buildings used for Civil Defence purposes, etc. These must be attended to first. Buildings needing permanent repairs should be attended to after other buildings have been rendered first-aid. Experience shows that prior contact with all local builders and contractors is vital in order that an efficient organisation of the maximum strength can be brought into operation with the minimum delay, and builders should be encouraged to keep in stock such materials as tiles, glass, plaster board, timber scantlings, brick, etc.

It is preferable to have the materials on hand locally. Builders and Local Authorities' repair staffs should report at the depot as soon as possible after damage has occurred, and receive instruction " chits " to proceed with the repairs of groups of damaged properties (from information gleaned from the preliminary survey), the aim being to render weatherproof as many houses as possible within the first twenty-four hours. To achieve this, care should be exercised in deciding the order in which repairs should be carried out, as the more seriously damaged houses having been evacuated, can be left for a later decision. For instance, it will be found that a number of houses having damaged windows and slight roof damage can be rendered habitable within the same period as, say, one house which requires complete retiling.

[1] *Vide* Ministry of Health Circulars Nos. 1810, 1848 and 2144.

As the whole work is carried out at a rapid pace by a large number of contractors, it is necessary to keep as close a check as possible on the repair instructions issued, to avoid unnecessary overlapping. For this purpose a cross-indexed record of all properties dealt with, set out under street names and contractors, would be found beneficial in checking accounts and compiling the Schedule of Properties. In view of the different methods adopted by builders, it is advisable to produce some standard form of time sheet for issue to all builders and contractors, which will enable the clerical side of the work to be simplified when preparing accounts.

A second survey indicating particulars of damage to roofs, walls, floors and contents, etc. should be made for carrying out permanent repairs. Since numerous houses of varying sizes and types with a variety of damage have to be dealt with it is necessary to adopt some system and prepare an " omnibus " specification, covering materials, workmanship, and schedule of repairs. A combined job sheet and tender form for each property should then be prepared wherein the contractor should state the lump sum price for the permanent repair and the number of days in which he can complete the job. To expedite all these, additional staff may be found necessary, and civic authorities should make provision beforehand.

To facilitate war damage repair the civic area should be divided into wards and representatives of the local building industry should confer together with the civic authorities, and each allotted their respective zones. In some cases owners would like to assume responsibility for their own repairs. A list of such property should be prepared in advance, and kept with the authorities. Care should also be taken to discover frivolous reports of war damage.

In the case of 'permanent' repairs a second survey of each property should be made. A schedule of repairs should then be prepared to each property. This should embody a brief specification of the work to be done together with approximate quantities, *i.e.*, the number of new tiles required ; the number of chimney stacks or pots to be rebuilt ; the area of plaster to walls and ceilings to be renewed ; the number of shades, doors, etc. to be repaired or replaced ; and the number of squares of glass, with approximate

sizes ; from this schedule an estimate of the cost of repairs should be prepared.

The practice of inviting competitive tenders may prove unsatisfactory, as has been done in some English Boroughs, owing to the time involved and the natural desire of the Builders to provide for every contingency. In the interest of economy and efficiency, all repairs should be executed on a common basis as allowed for first-aid repairs in Great Britain. This will be more equitable to owners. All repairs must be supervised by the technical staff of the Engineering Department of the Civic authority.

The procedure to be adopted for salvage of property and clearance of debris should be as follows :—

Roads blocked by debris should be dealt with as soon as possible after the incident by the Road Repair Squad. Structures which are dangerous to roads or adjoining property should receive immediate attention from the Rescue and Demolition Parties. Special salvage squads should be sent to major incidents to assist owners in the salvage of properties and furniture from dangerous structures. Arrangements must be made to remove and store furniture and other articles from property, scheduled for demolition, priority being given to cases where the furniture is exposed to the weather.

Regarding demolition, priority should be given to sites where the damage is most likely to have a depressing effect on the morale of the public and wherever possible work should not commence until the owner is consulted. Majority of the material salvaged should be taken to a special depot established for the purpose where detailed records of the materials salvaged should be kept by a store-keeper. In suitable cases the salvaged materials should be taken direct from the site for use in repairing adjoining property or the construction of domestic shelters. Comprehensive and up-to-date records of all matters relating to war damage has to be kept. Civic authority should act as the co-ordinating authority for the salvage and demolition scheme throughout the city.

While the removal of goods and articles is the responsibility of the owner, assistance may be given by the Local Authority in salvaging furniture and valuables. Where alternative housing

accommodation to which furniture can be moved is not immediately available, a suitable building should be requisitioned under Defence Regulations and goods taken there for temporary storage. Local Authorities should look after the goods of owners who cannot be traced and protect them from further damage.

The Ministry of Home Security emphasises in its circulars that immediate attention should be given to the clearance of streets and the removal of debris from the building sites need not be undertaken as a matter of absolute urgency. Of course, regard should be paid to the depressing effects of mutilated buildings, if allowed to remain for lengthy periods. H.S.C. 209/40 states that regarding urgent demolition of dangerous structures the Engineer should inform an Officer of Police not below the rank of Inspector and start demolishing. In the interest of public safety the Engineer should take a broad view on matters of demolition.

To facilitate the removal of demolished materials from the site the practice recommended is the purchase, as far as is practicable, of the damaged properties, excluding land. Prices paid for small terrace type houses have varied from £10 to £15. Rescue and Demolition Parties have been used for such work, but the operational efficiency of the rescue services should not in any way be impaired by such work.

Food and Drink, Clothing and Cash

One of the most urgent needs of the Blitzed areas is good and stimulating beverages. Recently Her Majesty the Queen gave a convoy of fully equipped vans to rush food and drinks to towns which had been subjected to severe bombing. These have proved a great boon to the stricken populations and are named Queen's Messengers. This has been followed by a new organisation, "Blitz trailers". The trailers are small, easily managed, are capable of being drawn through the streets during a bombardment, if need be, by man-power instead of the motor power for which they are actually intended. One trailer is being sent to each Civil Defence regional area to be loaded up with hot soup, tea, blankets, clothing, anything immediately needed by people bombed out of their homes.

Eighteen food-flying convoys, each costing £5,000 are stationed at key points throughout Britain ready to rush hot meals to any blitzed area.

Each convoy will have eight vehicles—one 350-gallon water tanker, two lorries each containing 6,000 meals (tea, wholemeal, bread, margarine and vegetable stew), two kitchen equipment lorries and three canteens. Insulated containers keep the stew hot. The vehicles have been specially designed for mobility. They can cross rough ground and bomb craters. Five despatch riders on motor cycles will travel with each convoy to maintain communication with stricken areas. Each convoy will have a staff of thirty.

Mobile kitchens also play a very helpful role in raided areas of England and Scotland. They can be rushed to the scene of distress and provide meals for those who have lost their homes and means of cooking. They are rushed to the blitzed areas soon after a raid. They supply tea, coffee, sandwiches, cakes, cigarettes almost anywhere where they are needed and do wonderful work in the big cities. They are extremely helpful especially to the A.R.P. personnel to carry on their diverse tasks in the bombed area.

Feeding arrangements are also made for children in the vulnerable zones. Young children eat their lunch at feeding shelters in London.

Private individuals too help in providing food in times of distress. Miss Violet Markham, well known social worker, has recently set up a canteen at her own expense in a very poor neighbourhood just outside London, doing most useful work. It serves shelter folk night and early morning, as well as homeless people, and those who find it difficult to cook owing to shortage of gas and water. Tea and sandwiches are specialities, a large cup of tea costing a penny and a large sandwich the same price. It is staffed almost entirely by voluntary workers.

Clothing and comforts for bombed-out people are provided for: especially clothing for children. The National Council of Girls' Clubs, London is doing good work in this connection. It received 8,000 garments for distribution among the bombed-out children.

Relief for air raid victims in the shape of food, clothing and cash for small immediate necessities is distributed through the

civic heads in Britain; grants are also made towards the cost of funerals and the removal of furniture to new homes—the grants are given for immediate distress arising from enemy bombing—the policy and administration of the Lord Mayor's Air Raid Distress Fund are now carried out by a council made up of representatives elected by the Civic Heads in each Civil Defence region throughout the United Kingdom with the Lord Mayor of London as Chairman. A local Committee set up in each region allocates grants to such civic authorities as may need assistance for the relief of air raid distress in the respective areas. The fund amounted to more than two million pounds in January 1941 and grants amounting to £800,000 were already made.

A.R.P. for Animals

At the request of the Home Office, the National A.R.P. Animals Committee was recently formed for organising protection for animals against air raids. The aim of the Committee is to have a guard for every street who will be the contact officer between the first-aid posts and animal owners. Through his agency, restoration of animals lost or strayed in air raids will be simplified, and it will be the duty of the guard to make known to animal owners the address of the nearest first aid posts and to give information regarding A.R.P. for animals. Under this scheme each registered animal will be given an identity disc, which, apart from serving its A.R.P. purposes, will enable lost dogs and cats to be restored to their owners. It is suggested that this work is eminently suitable for the local women's organisation, as the duties of guards are not onerous and they will not be called upon to handle injured animals.[1]

The National Air Raid Precaution Animals Committee Hospital has been established to deal with animal casualties. Animal ambulance stretchers are used to carry dogs, etc.

In Manchester, the National A.R.P. Committee for animals have opened a depot and registration branch; voluntary workers visit houses in all parts of Manchester and Salford and prepare a register of domestic pets. Every registered animal is issued with a split ring and identity disc to identify the pet when injured or dead.

Gas drill for dogs has also been prescribed. The first point about gas drill for dogs is to get the animals used to seeing their

[1] 'Safety News', April 1940.

owners and family wearing gas-masks. Unless this is done, the dog might disobey orders coming from such a strangely disfigured human image, especially on an occasion of quick movement and a certain amount of excitement. Secondly, the dog should be accustomed to the occasional use of its gas-proof kennel, or box, which has a wire net door covered with wet blankets or sheets (not sodden or dripping) if nothing more elaborate. Dogs will rarely consent to wear gas-masks.

The size of a gas-proof shelter is also determined. It appears that a medium-sized dog breathes out 0.3 cubic feet of carbon dioxide per hour. Taking healthy air as containing 0.05 per cent. of carbon dioxide, the dog requires 1,500 cubic feet of air per hour, and, therefore, for a one hour's period in its shelter, 160 cubic feet of air space. A man breathes out about twice as much carbon dioxide as a dog. One useful hint is to place soda lime in a receptacle in the shelter during a gas raid, as it absorbs carbon dioxide.

The possibility of an animal becoming hysterical in the street should be avoided both in the interest of the public and of the owner.

Unexploded Bombs, A. A. Shells and Crashed Air-craft

Provision to deal with unexploded bombs, unexploded A. A. shell sand crashed air-craft should be made. The work should be entrusted to trained specialist parties. The position and type of any of these occurrences should be immediately reported. All A.R.P. personnel should send relevant facts to help the specialist parties to reach these spots quickly.

UNEXPLODED BOMB :[1]

Its immediate vicinity should be cleared of all persons. Houses in the danger zone should be evacuated and the public in the street should be warned. Traffic should be diverted from the zone.

[1] The problem of detecting and destroying bombs is receiving considerable attention in America. In New York, N. J., U. S. A.; the Bomb Squad carried out considerable experiments with models to master the technique of detecting the dangerous contents of bombs and successfully destroying them. The diagnosis is done by a listening device or by a powerful portable fluoroscope for photographing the inwards. (The " American City," Aug. 1941, p. 15).

" In open spaces the danger zone of an exposed unexploded bomb may possibly extend up to a range of 1,200 yards. If the bomb has penetrated to such a depth as to be invisible, a minimum of 250 yards should be allowed. Crowds should be discouraged from congregating even at these distances."

In built-up areas, the effect of blast varies greatly and the following precautions are recommended :—

1. In ordinary straight streets, the houses covering a frontage of 100 yards on either side of the bomb should be cleared of occupants.

   In the remaining houses of the street the inhabitants should be instructed that, if they remain indoors, they should keep to rooms on the unexposed side of the house until advised that the danger has passed.

2. In crescents and squares all houses within 200 yards of the bomb should be cleared.

   In the remaining houses of the crescent or square the inhabitants should be instructed that, if they remain indoors, they should keep to rooms on the unexposed side of the house until advised that the danger has passed.

3. In all cases every window in all houses in the street, crescent, or squure concerned, should be opened as wide as possible until the danger has passed. If a person in the danger area has to leave his house, he should so far as possible move in a direction away from the bomb, and use any cover afforded by intervening houses.

A.A. Shells :

Shells from A.A. Guns may fail to burst and be found unexploded on the ground where they would remain as " dud shells " until removed by trained specialist parties. Care should be taken to ensure that they are not tampered with by unauthorised persons.

Crashed Air-craft :

Crashed air-craft, or those forced to land, may catch fire. This may cause fuel tanks to explode and any unexpended

machine-gun bullets to be discharged. The heat may also detonate bombs contained in the fuselage, and, even in cases when no fire has resulted, bombs hidden from view might be set to explode after an interval of time.

In all cases, therefore, of air-craft which have been forced to land or have crashed, the precautions to be followed are the same as for unexploded bombs given above.

Compensation for Air Raid Damage to Civilians

A noteworthy fact among the precautionary measures adopted in Great Britain against air danger to civilians, is the provision of compensation for the damage done to their person and property by enemy action. A scheme of insurance was prepared soon after the declaration of hostilities, for civilians injured in air raids. It was amended in July 1940. This amended scheme of compensation for physical injury sustained by civilians as a direct result of warlike operations, had the effect of bringing the whole civil population under its purview against injury caused by air raids or invasion, if they were gainfully employed at that time.

The amendment increased the allowances and pensions to meet the rise in the cost of living.

A married man with two children, was to be given fifty-three shillings eleven pence weekly, if totally disabled.

Within a short time, about 127 pensions were granted under the scheme, either for serious disablement or to widows: The Ministry deals so expeditiously with pensions that in one case the widow of an air raid warden to die on duty received her pension within twenty-four hours of his death.

Compensation is also given for essential clothing and furniture lost by raid victims. A maximum of £30 for clothing, £50 for furniture was fixed. These were relaxed and increased. By the beginning of 1941 a free insurance scheme was formulated covering all civilians who suffered air raid damage. As outlined by Sir Kingsley Wood, Chancellor of the Exchequer in the House of Commons in February 1941, " every householder in Britain will receive free compensation from the Government upto £200 for air raid damage to clothing, furniture and other household goods, under

the new Government free insurance scheme. Upto another £100 free compensation will be paid for wife and £25 for each child."

In addition to these free grants, the proposal has been made that people should be able to insure at low rates, namely, at one per cent. upto £2,000, 1½ per cent. from £2,000 to £3,000 and at 2 per cent. from £3,000 to £10,000.

The finances of the State do not warrant such schemes for India, but some provision must be made for protecting the interest of those who are compelled to stay on at their work, and for their dependents. Those who must stay in vulnerable areas to help the maintenance of essential services or other necessary work should be brought within the scheme of insurance and their employers made responsible to pay, with the assistance of Government, if absolutely necessary. Otherwise people will leave their posts and there will be a break-down in the supply of essential services as well as in production, for unlike industrialised countries, those people would adjust and not fear to face hardship, and go back to land.

Equally necessary is the organisation to record and notify casualties in case of an emergency and for the disposal of the dead in an enemy air raid. As has been suggested by the Government of Bengal[1] this organisation should be responsible for identification, transportation and disposal of bodies and of valuables found on bodies, and for decontamination of gassed bodies before burial.

The organisation must keep in close touch with the A.R.P. organisations and the hospitals, casualty services, report centres, and wardens, and have a suitable staff and maintain a sufficient number of vehicles for transport of bodies and the necessary registers.

The Government of Bengal have requested the Calcutta Corporation to draw up a comprehensive scheme on the lines suggested for the Municipalities in the vulnerable areas in the district of Hooghly, Howrah and 24-Parganas and in Asansol and Chittagong. It is hardly necessary to add that the scheme should be extended to all vulnerable areas and suitable sites selected to cremate the dead.[2]

[1] *Vide* "Mail", 30-8-1941.

[2] Even coffins were made and kept ready in some towns of England before the severe Nazi *blitz* over the country.

The siting of cremation or burial grounds is a problem that needs careful consideration under war conditions. During the last war due to lack of foresight this problem created difficulties and complications. The fact is that cremation and burial have to be done with sufficient foresight as otherwise it hinders the growth and healthy development of cities. It will be found very difficult, for instance, to deal with war graveyards, when questions of planning and development are taken up by planning authorities for post-war reconstruction. The areas, therefore, must be zoned now itself. If all dead bodies are cremated the matter would be simplified. Until burial is allowed, grounds should be reserved and their zones given due consideration under war conditions, to avoid difficulties in the towns of to-morrow.

Women and A.R.P.

Women have as important a role to play in Civil Defence as men. Indeed they are superior to men for certain essential services after a raid, such as nursing, feeding, etc. In India women A.R.P. workers are essential because the *purdha* is in vogue in many vulnerable cities and towns.

Women in England are doing a great deal to help A.R.P. and their work indicates the wide scope that lies before them.

When the present war broke out, the Women's War Service Organisations quickly sprang into being under the popular abbreviated titles of A.T.S., W.A.A.F.S., and W.R.E.N.S. The A.F.S. and A.R.P., moreover, gave women scope as telephonists, air raid wardens, air raid shelter marshals, and as ambulance drivers. Women to-day are also employed as "roof-spotters" and women air pilots are permitted to fly newly-built air-craft from the factories to the air stations. Members of the A.T.S., specially trained at an artillery school, are working on the kinetheodolites in conjunction with the A.A. batteries. The work requires a high degree of skill and accuracy and courage, and is often carried out under conditions of actual warfare.

In addition to ambulance driving, telephone operating and other war-time duties, the Women's Mechanical Transport Corps now have their own despatch riders. These girls keep communications going during air raids, etc.

One of the most interesting developments of Women's Voluntary Services during the past year has been Housewives' Service, which now has a membership of 204,000 women all over the country. They have enrolled to train for duties during and after air raids caring for children, practising elementary first-aid, providing hot drinks for A.R.P. personnel, assisting in emergency rest and feeding centres. For fire-fighting each member keeps buckets of sand and water ready in her house.

Many of our women would, however, find it difficult to do all these kinds of work but many of them could be easily trained for several of them. For effective education of the public—which cannot ignore the housewife in the Indian home, trained Women A.R.P. workers are essential in this country.

In certain cities a separate Women's A.R.P. Service has already been created, composed of, and officered entirely by women, who perform the duties similar to those performed by the members of the services mentioned above, except that there is no corresponding engineering section.

A note explaining the nature of work which will be undertaken by the Women's A.R.P. Services in one city, says that, " primarily their duty at present would be to help men wardens in their educational work by dealing with women. In places where *purdha* is in vogue, women could be successfully employed. Women's volunteer services and Ladies' work parties are being approached to help in the recruitment of these guards."

The Women's Air Raid Precautions Corps has been started in Madras and other cities.

Their aims and objects are to instruct women of all castes and creeds in self-help and in the rudiments of Air Raid Precautions, so that in times of emergency they may be of assistance to themselves and their families and also to the A.R.P. Organisation. The aims and objects of the organisation were recognised and approved by the A.R.P. Area Committee, and financial assistance was allotted towards expenditure incurred in connexion with Corps' activities. The Corps is under the command of the Commandant and is organised in two branches each with its Branch Leader, one for propaganda and organisation and the other for instruction. These branches are again sub-divided into Divisions, each Division

having its own District Leader and the Instructresses. This has been done to ensure that no woman has any great distance to travel to gain information and help. The Commandant has an Advisory Committee consisting of the Branch Leaders and ladies representing every community in the city.

Lectures are given in the vernaculars in a simple form for all to understand. Instructions to be given are such that all may be educated to help themselves in any emergency, air raids, fire, famine or pestilence.

A.R.P. for India

India's economic condition cannot permit a close copy of British Organisation but the main features might be incorporated. This is evident from the recommendations of the A.R.P. Sub-Committee appointed in Bombay. The report suggests :

1. Arranging air raid and "all clear" warnings,
2. Control of lights,
3. Organisation for dealing with damages caused, and
4. Education of the public.

The A.R.P. Organisation recommended by them consists of a whole time officer, a number of air raid wardens especially for premises or companies employing more than 300 or 400 persons. Air raid warning and all clear signals should be given by means of sirens to the general public, and by telephone to a selected number of subscribers who are intimately connected in concerns associated with civil defence and public utility services. Each siren would have a two-mile range and the "warning" signal would be denoted by the sirens wailing up and down at a four-second interval over a period of two minutes, the all clear signal would be a steady blast of two minutes' duration as recommended by the Home Office of Great Britain.

For controlling street lights in time of war, it is suggested that a combined scheme would be necessary to provide for :

1. Permanently reducing the number of lamps lit and the strength of each lamp lit ;
2. Providing shades to prevent glare ; and
3. Extinguishing all street lights on the receipt of an air raid "warning".

Measures recommended for the treatment of casualties and repair of damages to hospital accommodation, auxiliary fire services, volunteers, salvage work, provision of anti-gas equipment and education of the public, are also included.

For urban areas with a population of over 10,000, such organisations are essential. But the question of rural areas may be postponed for the present. The main risk to inhabitants of a rural area is from bombs dropped at random, and the likelihood of a house being hit, or of casualties occurring depends on the relative areas of occupied and unoccupied ground. Casualties should therefore be few, even if many bombs fall, and such as would occur would be more likely to be single casualties.

Such a state of affair does not justify elaborate precaution. Local organisations with air raid wardens on the scale of perhaps 3 per 500 population with first-aid boxes and some protective equipment as suggested by the Home Office of Great Britain for rural England, might be adopted for villages of over 5,000 inhabitants. A first-aid point and some trained attendants and provision to get decontamination squads from the nearest urban centre should be made. Voluntary help from the villagers must be enlisted.

Air Raid Precautions in rural districts will therefore consist in the main of enrolling and training the allotted number of wardens, and providing the allotted number of first-aid parties, rescue parties and decontamination squads.[1] First-aid posts and points will also be provided. The assistance to purely rural areas, in the unlikely event of serious damage or a number of casualties occurring in them will depend on mobile parties coming from elsewhere.

In Indian cities, considered vulnerable, A.R.P. Organisations have been set up and during the last two years considerable progress has been made. An idea of the rapid progress made in Indian cities could be had from the following statistics which refer to the Madras Fortress Area.

The total number of trained wardens at the end of February 1942 was 4,695; 135 persons were also undergoing training.

[1]Home Office A.R.P. Dept. Circular No. 10/1939. Air Raid General Precautions in Rural Areas.

The present strength of volunteer messengers is 580, of whom 25 are despatch riders. A further batch of 166 messengers hav been recruited and they are undergoing training.

For the 28 First-Aid Posts located within the city limits, 92 Doctors, 164 Nurses and Midwives and 201 First-Aiders have been allotted. Six Doctors, 8 Nurses and 14 First-Aiders have been allotted to the four posts in the outlying areas in the Chingleput District.

There are now 91 First-Aid Parties, out of which 46 are voluntary and 45 paid. The paid parties are posted permanently at the seven combined Depots so far established. For the paid nucleus of the Rescue Service, Moplahs from Malabar are being recruited and trained in lifting heavy weights and in erecting and dismantling machinery. Those who have already arrived are given regular training every day in practical rescue work, in the use and care of equipment and on A.R.P. matters in general.

Subsidiary schemes are made for Government buildings and private firms and offices.

A.R.P. Publicity Officers have been appointed. All possible steps are being taken to educate the public about the measures to be taken by them in the event of an emergency. House to house propaganda is also being organised. The assistance of the All-India Radio and the Cinema theatres in cities are also being enlisted in this connection.

Civil Defence now forms part of the Central and Provincial Government activities: Madras allotted Rs. 60 lakhs for Civil Defence for 1941–42, Bombay Rs. 70 lakhs, U. P. Rs. 80 lakhs and Bengal Rs. 168 lakhs, and the Punjab Rs. 40 lakhs. The Department of Civil Defence at the Centre frames the policy and exercises supervising function over the activities of the Provincial bodies. Advice and information are offered to the public as well.

Organisations in India generally follow the lines of the English system suitably modified.

A.R.P. forces throughout areas in India regarded as vulnerable are under mobilisation, following Japanese aggression in the Far East and as a result of the Civil Defence Conference held in Delhi in

November 1941. The mobilisation is proceeding on the basis of whole-time work and payment for a large proportion of them.

Provinces are going ahead with the taking up of necessary buildings, motor vehicles, etc., both for intensive training and for active A.R.P. work. Reinforcement of essential material between the west and east of the country has been arranged and is in actual progress.

Local authorities make arrangements to establish rest centres and feeding centres for homeless people. Lists of casualties are to be published as quickly as possible and posted outside the local municipal offices where information from hospitals and first-aid services will be collated. Besides the wireless and news bulletins, loudspeaker vans will tour the streets.

Provincial Governments have prepared schemes for the dispersal of population, the establishment of evacuee camps and emergency food and rest shelters. Some have already been established.

The main idea, however, is that those who can get away from congested areas or big towns should be enabled to do so. From this point of view, therefore, the voluntary exodus of people from Calcutta is considered a great advantage. But as regards those who depend for their living on work in cities, the plan is dispersal and accommodation in temporary camps, about a mile or two away, so that they can go to their places of work and return and still be away from the conditions of congestion inside the poorer quarters of the cities.

For the vast majority of the poorer population, however, it is emphasised, the slogan is: " Stay in your house. Do not get out to look for a safer place, because the odds are that you won't find a safer place."

Pucca shelters, such as those in England, are not considered desirable in India. It is explained that experience in England has shown the danger arising from the falling in of shelters, killing a great number of people, who otherwise would have been safe, and the dangers of casualties due to a panic rush for the shelters are great and must be guarded against. It is learned that an expert is now in Calcutta advising the authorities on the technique of building elaborate shelters.

Next to the hole under the bed, the best thing is stated to be slit trenches ; but these are not possible in some parts of the country particularly Calcutta, where water is reached when two of three feet of earth are dug.

MOBILE FIRST-AID POSTS:

The Central Government have circulated a scheme under which in the less densely developed and populated areas, fixed first-aid posts might be replaced by mobile first-aid posts, which could be used, in effect to set up an aid post as and where required. Experience in England has shown that mobile first-aid posts can largely be used instead of fixed aid posts in suburban areas and that even in thickly populated areas, they are likely to prove useful for replacement or reinforcement of the fixed aid posts which might be destroyed or swamped by a large number of casualties. These mobile first-aid posts will not be in addition to those fixed aid posts, which have already been selected and sanctioned but would replace some of the fixed first-aid posts, according to local conditions.

TRAINING OF ROOF SPOTTERS:

Further progress is reported in connection with the Scheme for the training of roof spotters. This scheme, prepared in conjunction with the Air Staff, is intended to ensure that work in vital factories, important commercial firms and Government offices, is dislocated as little as possible by air raids. Roof spotters are intended to warn the occupants of premises concerned of the approach of hostile air-craft in sufficient time to enable them to take shelter before an attack develops. To assist roof spotters in the task of identifying hostile air-craft, the Central Government have under consideration a scheme to supply them with playing cards on the reverse of which will be illustrations of various types of enemy air-craft.

The decision is understood to have been taken to split the existing Central A.R.P. Training School in Calcutta into two schools, one for officers and the other for instructors. The school at present has accommodation for thirty-five officers and forty-five instructors, and as a consequence of the suggested establishment of two schools, the output of officers is expected to be doubled and that of instructors to be quadrupled.[1]

1 "The Hindu", 21-12-41.

The Government of India have just promulgated a new rule under the Defence of India Rules concerning the responsibilities of local bodies in certain contingencies. The rule empowers the Central Government in respect of cantonments and other areas in their direct jurisdiction, and the Provincial Governments in respect of local authorities subject to their control, to require such authorities to take such measures as they (the Government) may deem necessary for the protection of persons and property under the control, or within the jurisdiction, of such authorities from injury or damage or for ensuring the due maintenance of the vital services therein. These powers are to be exercised only in the event of hostile attack. In such an event, it shall be the duty of the local authority to comply with the order. The rule also provides that the funds of the local authority shall be applicable to the payment of the charges and expenses incidental to such compliance, priority being given to such compliance over all other duties and obligations of the local authority. The new rule goes on to lay down that the appropriate Government shall be entitled to carry out the orders at the expense of the local authorities " without prejudice to any other proceedings which may be taken in respect of the contravention of the order."

The Government of Madras direct the owners or occupiers of all buildings within the Madras Fortress Area to provide themselves with water, sand, sandbags and shields on a scale fixed by them.

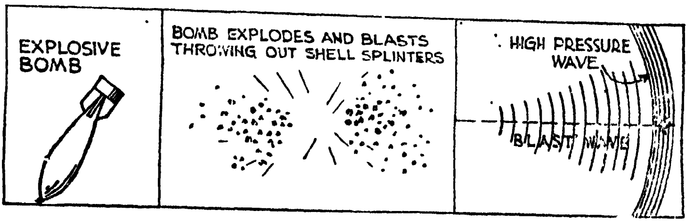
The Government have decided that sandbags should be provided free to the owners of *kutcha* tiled houses and thatched houses. These sandbags must not be sold or otherwise disposed of without the prior permission of the Government. All householders should make their own arrangements to obtain the quantity of sand required by them.

Various measures to prevent break-down of essential services have been adopted and people are advised on many other points. For instance in the event of the sewage system in the city breaking down owing to enemy action, flush-out latrines may cease to function. The owners of bungalows and garden houses are advised that, during such an emergency, they may open trenches or bore-hole latrines as a substitute for flush-out latrines. These latrines should be 30 to 50 feet away from wells used as drinking water sources. Trenches should not be dug on loose soil. Sites where sub-soil water level is nearer than six feet from ground levels should be avoided.[1]

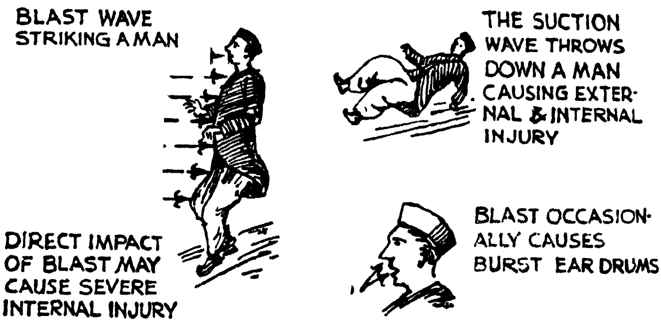
[1] "The Hindu", 27-3-42.

Education and Training

The success of A.R.P. organisations depends largely on public co-operation, for A.R.P. affects every aspect of life. Education assumes great significance. Citizens enlightened in A.R.P. consti-



The action of High Explosive Bomb

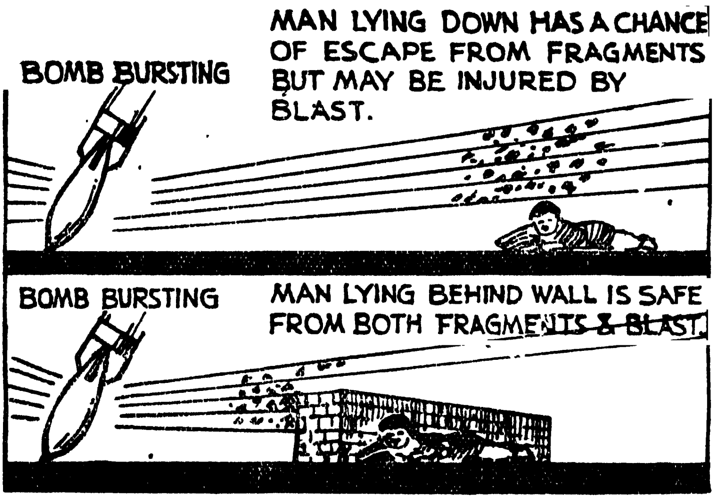


How High Explosive Bomb effects affect persons

tute the foundation of air defence. "If the emergency comes the country will look for her safety not only to her sailors and soldiers and air men but also to the organised courage and foresight of every household."[1] Authorities feel that "it is of essence of any such preparation that the civil population should be informed of the present and future possibilities of air attack and instructed in the precautions designed to meet it." Even in enlightened England the Home Office has taken particular care to disseminate correct and ample information through its invaluable handbooks and circulars and the need in India where A.R.P. is new cannot be exaggerated.

[1] The Protection of Your Home against Air Raids. (Home Office).

The other aspect of education consists in the training of personnel directly engaged in A.R.P. work. From decontamination and fire-fighting to the handling of evacuees and erecting air raid



Enlightened citizens can escape danger by simple and easy measures

shelters, efficient training is required. St. John's Ambulance, the Red Cross organisation, etc., form valuable nucleus. The foundation for an anti-gas training centre now exists in Belgaum as also a factory for the manufacture of gas-masks. The training centre at Bombay imparts instructions to air raid wardens and informative lectures to enlighten the public. The A.R.P. Staff School at Calcutta trains A.R.P. personnel.

But these must be supplemented by schools of A.R.P. on the model of the Home Office Air Raid Precautions School at London. Courses of this school last for three weeks. The full cost of instruction is borne by Government. The course is intended for officers engaged in the preparation of Air Raid Precautions schemes under the Air Raid Precautions Act and Regulations, whether they are permanent officials of the authority selected for these special duties or whether they are officers specially appointed for the purpose. Officers should not normally be sent to the school immediately on appointment. Before attending a course they should have had an opportunity to make themselves familiar both

with the organisation of local government in their districts and with the handbooks and memoranda issued by the Home Office, as otherwise they will not be in a position to take full advantage of the course.

The purpose of the school is to train officers charged with the preparation of general air raid precautions schemes and the instruction given do not in any way supersede the specialised training in anti-gas measures which is at present being conducted at the two Civilian Anti-gas Schools at Falfield and Easingwold. The type of course given at present is designed to provide a background to the subject of air raid precautions organisation and to convey information about certain national aspects of air raid precautions with which officers of local authorities would not normally be familiar. Arrangements are made for specialised lectures to be given by officers of the Air Raid Precautions and other Departments on general questions of organisation and on special questions such as medical organisation and problems of structural protection.

The school also serves as a focal point for the accumulation and dissemination of the knowledge and experience acquired by Air Raid Precautions officers in handling the practical difficulties arising in applying the general principles laid down to the circumstances of their own area.

One such school[1] for every province attached to the Provincial A.R.P. Organisation and the Board of Survey and Investigation is absolutely necessary for this vast country. More will be needed to produce enough persons to man the A.R.P. Organisation for India to cover thirty million people distributed in over 1,000 centres.

A.R.P. methods, materials and specifications now recommended in India, are based upon the B. S. S. Conditions in India being different, tests should be made to discover whether these stand our climatic and geographical conditions, which vary all over the country. It is high time that Indian Standards are evolved for the materials. Actual tests should be made to assess their resisting power, against aerial bombing.

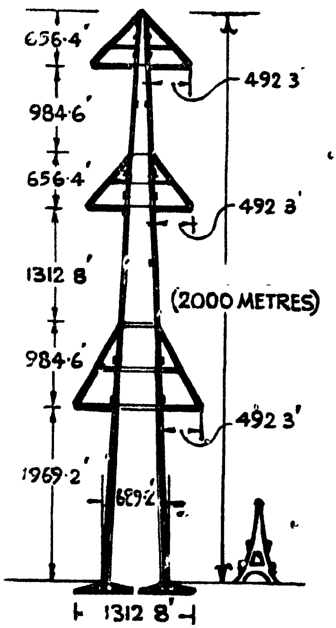
A Central Board should be established for this purpose. Regional Centres should also be created to test the materials available in the region. Experience in Europe and in Far East would provide

a basis to work upon. These boards would co-ordinate research work in A.R.P., and building materials. Government, however, should subsidise schemes and make Indian requirements self-sufficient and self-reliant. Such impetus is bound also to develop the materials required for post-war reconstruction.

Enlightening the public on A.R.P. is the other vital aspect of education and all conceivable methods are utilised in England to render this successful. The radio, the cinema, lectures, handbills, pamphlets, etc., are all resorted to; the series of most authoritative publications on the subject has been published by the Home Office. The services rendered by technical bodies and associations, through their publications, discussions and memoranda are invaluable.

It is imperative that the public in India is enabled to possess correct ideas as to the different aspects of the problem and the task would be facilitated if the Provincial Government, the local bodies like Corporations and Municipalities, and Unions managing urban areas, District Boards, and educational institutions undertake this task before India is plunged into gloom. It is desirable that local bodies are compelled to know the ABC of A.R.P. It is even more essential that students and the coming generation should be acquainted through their institutions, of the art of planning for peace and protection from raids.

Advisory Boards consisting of experts—official and non-official—with experience in Indian conditions should be formed to achieve this purpose. As has been suggested already in parts of India, non-official bodies are indispensable for effectively spreading A.R.P. knowledge to those who constitute the bulk of India's population. The confidence of the public is more easily aroused by their activities.



Living in towers of this kind has been suggested to eliminate the danger of air attack. Its gigantic proportion could be imagined from the Eiffel Tower which is drawn to the same scale

Further in matters of A.R.P. routine methods of operation should give place to quick action during emergencies. This body would study the varied questions that face the problem of Civil Defence and devise ways and means with imagination and thought, viewing the problem of Civil Defence in its whole perspective. All this is essential to achieve economy, efficiency and sufficiency in operations and administration of Civil Defence.

Air raids have come to stay, and unless some miracle happens and changes the nature of man, it is necessary to concert measures to resist them. "I can see little hope within any measurable period of time," said Sir Clement Hindley, "of obtaining for the human race in any part of the world permanent immunity from attack from the air of evilly disposed persons or organisations." If Sir Clement's warning should not go unheeded it is incumbent on our part to prepare ourselves and nothing is more valuable in this preparation than the imparting of correct knowledge to the citizen of to-morrow. If the principles of Civil Defence should form part of the curriculum of studies the justification is to plan ahead for decades to minimise India's vulnerability to air attack, probably to such a level as to render air raids not worth while.

Herein lies the goal of A.R.P. for India—the ideal that should always guide the measures we undertake, however urgent may be the immediate need for precautions. The need for a two-fold programme has been emphasised in all vital aspects of A.R.P. whether for shelters, or for evacuation or for precautions for structures. Technical Press has demonstrated the importance of a dual programme; and the Government of Great Britain, in their innumerable circulars repeatedly emphasise the idea. We will do well to realise however oppressive the need of the hour may be, that real security for our teeming millions lies in effective planning for protection.

APPENDIX TO CHAPTER IX

Famous Buildings in Britain Damaged by Aerial Attack.[1]

HOSPITALS.—Charterhouse Clinic, Great Ormond-street; London Hospital; Queen Mary's Hospital; St. Bartholomew's Medical School; St. Thomas's; Swiss Relief Centre; St. Dunstan's Headquarters; Ford's Hospital, Coventry; and American Ambulance Unit, Tunbridge Wells.

CHURCHES.—Westminster Abbey; St. Paul's Cathedral; Canterbury Cathedral; St. Martin-in-the-Fields; St. Celement Danes; St. Giles, Cripplegate; St. Swithin's Cannon-street; St. Augustine, Watling Street; St. Boniface, Alder-street; St. Sunstan-in-the-East; St. Clement's, Eastcheap; Jewin Chapel; Dutch Church, Austin Friars; Swedish Church, Rotherhithe; St. Magnus the Martyr; St. Mary-at-Hill; St. Mary Woolnoth; St. Margaret's, Westminster; Christ Church, Westminster Bridge-Road; St. John, Smith-square; St. John's, Kensington; Our Lady of Victories, Kensington; St. Mark's, Regent's Park; and Islington Parish Church.

EMBASSIES.—American (time bomb removed); Japanese (evacuated); and Spanish.

PALACES.—Buckingham Palace, Kensington Palace, Lambeth Palace, and Eltham Palace.

OTHER BUILDINGS OF WORLD-WIDE INTEREST.—House of Lords; British Museum; Law Courts; Tate Gallery; Imperial War Museum; Somerset House; Wallace Collection; Burlington House; Tower of London; Westminster Hall; Temple; Inner Temple Library; Stationaries' Hall; Royal Hospital, Chelsea; Hogarth House; Holland House; Radnor House, Twickenham; Statue of Richard Cœur de Lion.

PUBLIC PLACES.—Australia House; Bank of England (near); County Hall, Madame Tussaud's; National City Bank of New York; Public Record Office; South Africa House; University College Library; Yokohama House; Specie Bank; Y.M.C.A. Headquarters; The Zoo; Argyle Theatre, Merseyside; Arts Theatre,

[1] List issued by the Ministry of Information of the buildings bombed in Britain in 9 weeks during Septemb r–November 1940.

Birkenhead; Birmingham Art Gallery; Birmingham Town Hall; Royal College of Surgeons; Indian Students' Hostel; Italian Tourists Company; and Wimbledon Centre Court.

NEWSPAPER OFFICES.—Associated Press of America; *Daily Express*; *Daily Herald*; *Daily Mail*; *Daily Mirror*; *Daily Sketch*; *Daily Worker*; *Evening Standard*; *Glasgow Herald and Bulletin*, London Office, *New Statesman and Nation*; and *The Times*.

SQUARES AND STREETS.—Berkeley-square; Leicester-square; Kensington-square; Sloane-square; Smith-square; Berwick market; Bond-street; Burlinton Arcade; Bruton-street; Carnaby street; Lambeth-walk; Maddox-street; Oxford-street; Park-lane; Piccadilly; Regent-street; Rotton Row; Royal Arcade-Savile Row; Watling-street; Elephant and Castle.

STORES.—Austin Reed (Piccadilly); Bourne and Hollingsworth, Ford Showrooms, Regent-street; Gamage's, Cheapside; John Lewis; Peter Robinson, and Selfridge's.

CLUBS.—Arts (Dover-street), Carlton, and Reform.

BIBLIOGRAPHY

BIBLIOGRAPHY

Official Publications of the Home Office of Great Britain

A.R.P. Handbooks

No. 1. Personal Protection against Gas.
No. 2. First Aid and Nursing for Gas Casualties.
No. 3. Medical Treatment of Gas Casualties.
No. 4. Decontamination of Materials.
No. 4A. Decontamination of Clothing and Equipment from Blister Gases.
No. 5. Structural Defence.
No. 5A. Bomb Resisting Shelters.
No. 6. Air Raid Precautions in Factories and Business Premises.
No. 7. Anti-Gas Precautions for Merchant Shipping.
No. 8. The Duties of Air Raid Wardens.
No. 9. Incendiary Bombs and Fire Precautions.
No. 10. Training and Work of First Aid Parties.
No. 11. Camouflage of Large Installations.
No. 12. Air Raid Precautions for Animals.

A.R.P. Memoranda

No. 1. Organisation of Air Raid Casualties Services.
No. 2. Rescue Parties and Clearance of Debris.
No. 3. Organization of Decontamination Services.
No. 4. Organization of the Air Raid Wardens' Service.
No. 5. Anti-Gas Training.
No. 6. Local Communications and Reporting of Air Raid Damage.
No. 7. Personal Requirements for Air Raids, General and Fire Precautions Services and the Police Service.
No. 8. The Air Raid Warning System.
No. 9. Notes on Training and Exercises.
No. 10. Provision of Air Raid Shelters in Basements.
No. 11. Gas Detection and Identification Service.
No. 12. Protection of Windows in Commercial and Industrial Buildings.

No. 13. Care and Repair of Respirators.

No. 16. Emergency Protection in Factories.

A.R.P. Training Manuals

No. 1. Basic Training in Air Raid Precautions.

No. 2. Manual for Officers Responsible for A.R.P. Training.

A.R.P. Pamphlets

Aids to the Movement of Traffic to be installed in Roads and Streets in the absence of Street Lighting.

Anti-Gas Protection of Babies and Young Children.

Atlas of Gas Poisoning.

Detection and Identification of War Gases. Notes for the use of Gas Identification Officers.

Directions for the Erection of Domestic Surface Shelters.

Garden Trenches.

Notes on the Construction, Maintenance and Replacement of Sandbag Revetments.

Organisation of A.R.P. Services in Industrial, etc. Undertakings and the Training and Equipment of Personnel.

Protection of Foodstuffs against Poison Gas.

Protection of your Home against Air Raids.

Shelter from Air Attack.

Specifications, etc., in regard to Permanent Lining of Trenches.

Training of Air Raid Wardens.

War Time Lighting Restrictions for Industrial and Commercial Premises.

War Time Lighting Restrictions. Lights carried by Road Vehicles.

War Time Lighting Restrictions for Shops.

Government Evacuation Scheme.

Classification of Scottish Areas.

General Memorandum (Memo E. V. S. 3) June 1939.

A.R.P. Circulars, etc.

Air Raid Precautions.

Co-operation between Local Authorities and Occupiers of Industrial or Business Premises.

First Aid Posts.

Emergency Fire Brigade Organization.

Experiments in Anti-Gas Protection.

Air Raid Precautions Act, 1937.
Lighting Restrictions.
Air Raid Warning Signals.
Air Raid Precautions School.
Maps for use in connection with Air Raid Precautions Schemes.
Air Raid General Precautions in Rural areas.
Provision of Air Raid Shelter.
Steel Shelters, cases of flooding.
Air Raid Precautions Act, 1937. Summary of Provisions.
Stages in the preparation of a Local Authority's Air Raid Precautions Scheme.
Air Raid Precautions in Schools.
Teachers and National Service.
Air Raid Shelter Policy.
Sectional Steel Shelters. Report upon Investigations of the Standard of Protection afforded.
Air Raid Precautions. Compulsory Acquisition of Land. Compulsory Purchase Regulations.
Air Raid Shelters for Persons Working in Factories, Mines, and Commercial Buildings. Revised Code.
Memorandum on the Revised Code. Air Raid Shelters for Persons Working in Factories, Mines and Commercial Buildings.
A.R.P. in Industry.
Air Raid Precautions. Directions for the erection and sinking of the Galvanised Corrugated Steel Shelter.
Preliminary Memorandum on the Organisation of Air Raid Precautions Services in Industrial, etc. undertakings and the Training and Equipment of Personnel.
Air Raid Precautions Act, 1937. First Aid Posts and Points.
Report of the Committee on the Responsibility for the Repair of Premises damaged by Hostilities.
Civil Defence Act, 1939.
Air Raid Precautions in Museums, Picture Galleries and Libraries.

Books and Reports

J. B. S. Haldane: A.R.P.
H. M. Hyde and G. R. Falkiner-Nuttal: Air Defence and the Civil Population.

Cambridge Scientists' Anti-War Group: Protection of the Public from Aerial Attack.

"Ajax": Air Strategy for Britons.

Lt.-Col. Sisson: On Guard against Gas.

T. J. Muirhead: Air Attacks on Cities.

H. A. Jones: The War in the Air.

C. W. Glover: Civil Defence. III Edition.

Major N. De P. MacRoberts: A.R.P. Lessons from Barcelona.

J. B. Bilderbeck: A.R.P.

L. E. O. Charlton: War over England.

A. A. Spaight: Air Power in the Next War.

Mitchner and Cowell: Medical Organisation and Surgical Practice in Air Raids.

R. Ernest Dupuy: World in Arms.

Ellison Hawks: Britain's Fighting Forces.

Conference on Structural Air Raid Precautions, R.I.B.A. June, 1938. J.R.I.B.A., June 27, 1938.

Report of the Committee on Air Raid Precautions, the Institution of Structural Engineers, October, 1938.

Report of the Royal Commission on the Geographical Distribution of the Industrial Population.

The Hygiene of Housing (Bulletin of the Health Organization, League of Nations, Vol. VI, No. 4.)

The Census of India: 1931. Imperial and Provincial Tables.

R. Mukerjee: The Regional Balance of Man.

G. Vivian Poore: Essays in Rural Hygiene.

Aykroyd and Burnett: Public Health and Nutrition.

J. 47485. 100 New Towns for Britain.

Simms: Rural Sociology.

Gwilym Gibbon: Town and Country Planning.

Raymond Unwin: Town Planning in Practice.

H. V. Lanchester: The Art of Town Planning.

T. Adams: The Regional Planning of New York.

Anantalwar: Indian Architecture, Vol. I.

Journals and Periodicals

The Journal of the Town Planning Institute.

The Journal of the Royal Institute of British Architects.

The Journal of the Institute of Civil Engineers.

The "Builder".

The Journal of the Institution of Municipal and County Engineers.
The Journal of the Air Raid Protection Institute, London.
The Structural Engineer.
The Planners Journal.
The Town Planning Review.
The Architect's Journal.
The Indian Concrete Journal, Bombay.
The Political Quarterly.
The Sphere.
The Punch.
The Manchester Guardian.
The Times, London.
The Illustrated London News.
Hutchinson's Pictorial History of the War, London.
The Safety News.
The Times of India Illustrated Weekly, Bombay.
The Hindu, Madras.
The Mail, Madras.
The Indian Express, Madras.
The Statesman, Calcutta.
The Sunday Standard, Bombay.
The Sunday Times, Madras.

AIR RAIDS & CIVIL DEFENCE

By L. M. CHITALE, F.R.I.B.A., A.M.T.P.I.

OPINIONS AND REVIEWS ON THE FIRST EDITION

Private Secretary to His Excellency the Governor of Madras.

"...His Excellency realises the labour involved in its preparation and appreciates the spirit in which you have undertaken it..."

* * * *

Secretary to His Excellency the Governor of Bombay.

"...His Excellency......has seen it with much interest."

* * * *

H. E. General Sir Claude Auchinleck, G.C.I.E., etc.,
Commander-in-Chief in India.

"...One of the essential components of the Defence of India is an efficient A.R.P. Organisation. There is much in your book which will stimulate interest in this subject..."

* * * *

H. E. Sir Henry Duffield Craik, Bart., G.C.I.E., K.C.S.I., I.C.S.,
Governor of Punjab.

"...a most useful and comprehensive publication..."

* * * *

Secretary to His Excellency the Governor of Sind.

"...His Excellency was impressed by the all-embracing nature of your book..."

* * * *

The Hon'ble Sir A. Ramaswamy Mudaliar, Kt.,
Commerce Member, Government of India.

"...It is a comprehensive publication and must be of great value and assistance to those engaged in formulating air raid precautions. The practical suggestions you have made to suit Indian conditions will, I have no doubt, receive their careful consideration."

* * * *

The Hon'ble A. K. Fazlul Huq, Chief Minister, Bengal.

"...very pleased to go through your book...will serve the purpose for which it has been written..."

* * * *

Sir K. S. Fitze, K.C.I.E.,
Secretary to H. E. the Crown Representative.

"...contains much information that will be of real value to all those concerned with Air Raid Precaution work in India."

* * *

Lt.-Col. A. J. Reeve, Chief A.R.P. Officer, Government of India.

"...read your book with great interest. There is much literature on Air Raid Precautions, but little of it deals with India and its special problems. Your book has now filled this gap..."

His Excellency the Rt. Hon'ble Sir Akbar Hydari,
President, H. E. H. the Nizam's Executive Council.
"...very instructive and of great value in the present circumstances."

* * * *

Sir P. S. Sivaswamy Iyer, K.C.S.I., K.C.I.E.
"Congratulate you on having brought out such a valuable book on a topic of immense practical interest. Wide study of the available recent literature upon the subject and much thought have gone into the making of your book. There is no aspect of the problem of air raid defence which you have omitted to consider. Your book is comprehensive and will, I hope, create a wide interest among our people in the subject of defence against air raid..."

* * * *

Dr. Sir S. Radhakrishnan, Kt., D.Litt., F.B.A.,
Spalding Professor of Eastern Religions and Ethics, Oxford University; and Vice-Chancellor, Benares Hindu University.
"An invaluable and indispensable book...The practical solution suggested are intended to minimise human suffering and preserve and save intact the products of our culture and civilization from ruthless destruction...Hope this timely publication would receive the recognition it richly deserves..."

* * * *

Sir C. P. Ramaswamy Iyer, K.C.S.I., K.C.I.E.,
Dewan of Travancore.
"...a very valuable and timely publication...congratulate you on the extent and profundity of your information and the research you have brought to bear on the subject..."

* * * *

Sir R. K. Shanmukham Chetty, K.C.I.E., Dewan of Cochin.
"...excellent work...A.R.P. has now become inevitable part of our daily life. Your book is a timely and useful publication...will be of immense assistance to all those engaged in A.R.P. Organisation..."

* * * *

Rao Bahadur G. A. Natesan, Chairman, Propaganda Committee, Madras Provincial War Committee.
"...A good deal of useful information is given in a clear and concise manner... The authorities of all Corporations, Municipalities, Industrial concerns and A.R.P. Organisations would do well to acquaint themselves with the valuable information in this book and the practical steps suggested. It would be equally useful and profitable to the well-to-do citizen..."

* * * *

Mr. N. V. Modak, B.E., M.I.C.E., M.I.E., J.P. etc., President, Indian Institute of Engineers.
"Civil Defence, in its whole perspective, well presented. First and only book of its kind, best suited to eastern conditions. The Chapter on Post-War Reconstruction is of great interest. Useful to Engineers and A. R. P. Organisations, as well as Administrators and Educational Institutions."

* * * *

The "Jute Journal", Calcutta.
"...extremely timely publication. Mr. Chitale has made extensive researches and a deep study of contemporary problems and events. No pains have been spared to make a highly technical subject easily assimilable to the lay reader ...the work deserves a wide appreciation..."

The "Amrit Bazaar Patrika".

"...Mr. Chitale, an expert in architectural engineering...prescribes in his work many a protective measure...Mr. Chitale's book is particularly valuable...as it admirably summarises most of the information on A.R.P."

* * * *

The "Times of India".

"A welcome addition to the A.R.P. literature...a good introduction to the subject...is a valuable digest of the highlights of official literature...the problem is treated from all important angles."

* * * *

The "Statesman", Calcutta.

"Written by an Architect and Town Planner, this volume sets out the main considerations about defence against air raids. It gathers together information about Indian towns and their needs....Gas, fire, blast, splinters are all brought into review. Defences and shelters are considered....The book contains a great deal of varied information and a large number of illustrations...."

* * * *

The "Journal of the Indian Institute of Architects".

"Very comprehensive...noteworthy simplicity and freshness of presentation ...should be read by every intelligent member of the public."

* * * *

The "Bombay Chronicle".

"Excellent treatise...Commend this book to the Engineers, Architects, City Fathers and Administrators."

* * * *

The "Hindu".

"The author in his professional capacity visualises not only the immediate problems of the people but the even more important problem of the future development of our cities...the surest means of developing that interest is through publications which can be easily digested, such as the author has attempted to compile in his "AIR RAIDS AND CIVIL DEFENCE".

* * * *

The "Indian Express", Madras.

"Mr. Chitale's book...will make him (average citizen) realise with a shock just what an air raid means and what sort of protection is necessary...The whole book is a vast mine of information in most of the aspects of air raid defence...Mr. Chitale deals with the whole question in a thorough and comprehensive manner..."

* * * *

The All-India Radio, Madras.

"Strongly recommend to everyone interested in Civil Defence. It is indispensable for one and all engaged in A.R.P. It is a book of the hour and a book of the day. Everyone should read it."

For copies apply : The Author, Oriental Buildings,
Armenian Street, G. T., Madras.